MODERN X-RAY PRACTICE

AND

CHIROPRACTIC SPINOGRAPHY

REMIER

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VOL. XXI
REMIER
1957

8/28-57

Sincerely

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Dr. Perry D. Cook, Jr.

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and
Chiropractic Spinography

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BY

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Davenport, Iowa

FIRST EDITION
1938

SECOND EDITION
1947

THIRD EDITION
1957

Published by
The Palmer School of Chiropractic
Davenport, Iowa
U. S. A.

Practical treatise of modern X-ray practice and principle covering all branches of radiography of the human body.

Machine operation, placement, technique, darkroom and developing practice, preparation of patient, and all safe procedures dealt with in X-ray work.

●

A Tribute

To those living who so gallantly and faithfully
are fighting to their very end
And to the martyrs of this great science who
sleep in shrines of honor and inspiration,
Do I pay my deepest and most sincere respects.

About the Author

Percy A. Remier sampled many trades before he found his life's work in chiropractic spinography. Of French parentage, he was born at Galesburg, Illinois, on May 20, 1891. His earliest years were spent on a farm, and at six he began his education in a country school.

In 1900 the Remier family moved to Boulder, Colorado, where the father prospected for oil. But in 1902 the family returned to Galesburg, where young Remier entered public school. In 1905 he began his high school education. After school hours, and during summer vacations he worked first for a photographer; and later lured by the fascination of railroads, he became a call boy. It was his job to call railroad engineers and firemen for duty when they were needed.

From call boy he graduated in 1908 to machinist's apprentice in the railroad shops—experience which stood him in good stead in later years when he was to design and develop X-ray equipment.

In the winter of 1909, young Remier left the railroad shops to become a switchman; and afterwards, a locomotive fireman. But a year later he left the railroad to go to work at the Rock Island, (Ill.) Arsenal as a fourth-rate machinist. One week after he started this job, on March 23, 1910, he was married. That same year Remier took advantage of a government offer of schooling for those who desired to learn mechanical mathematics. Soon he became a toolmaker, and later, an assistant foreman at the Rock Island Arsenal.

Strangely enough, Remier's first work in chiropractic was as an artist when, in 1914, he made drawings, silver prints and all the measurements for Dr. John Craven's book on orthopedy. He also made several drawings for books written by Dr. James Firth, Dr. Harry Vedder and Dr. Ernie Thompson.

But at the same time he continued on at the Arsenal where, from 1917 to 1919—during World War I—he was a battery mechanic, working mainly on 75 mm French guns and three-inch American guns.

Then, on December 7, 1919, Remier began what was to be a lifetime association with the Palmer School of Chiropractic. He served from the first in PSC's Spinograph Department, interrupting his work at intervals to study X-ray under the leading men of his time at various schools and hospitals.

Meanwhile, he earned his Doctor of Chiropractic degree, and in 1932 he was placed in charge of PSC's X-ray Department, and assumed the position of spinograph analyst at the Palmer School.

Since that time, Dr. Remier has helped to design and build X-ray equipment; he has authored text books; written pamphlets and articles by the hundreds; has taught X-ray technique to thousands of student chiropractors and has lectured in practically every state in the union.

He remains today as one of the foremost analysts of X-ray films, and has read films sent to him from the far corners of the earth. In fact, so much in demand is Dr. Remier's analytical work on X-ray films that Dr. B. J. Palmer once remarked, in all seriousness, that Dr. Remier has read more than a million X-ray films.

It is this background which lies behind the production of this book.

—Paul Mendy

Dedication

Inasmuch as Chiropractic Spinography and its founder and developer met with the same barrage of criticism and misunderstanding which all other new ideas and their authors have, I think it very fitting and proper to dedicate this text to Dr. B. J. Palmer, the developer of Chiropractic.

The Genius

They could not understand him—he was one
Who walked on fire when others trod the clay,
Who followed mountain glimmers far away,
Or like an Eagle soared into the sun.
They could not understand him—there were none
Who roamed the highlands where he loved to stray,
Though, far below, the throng would snarl and bray,
Watching him mount where rainbow mists are spun.

And yet when at last, reviled and scorned, he died,
His name was set in gold and Deified,
Symbol for weeping millions to adore;
But still from cloud and crag he gleamed alone,
And still men praised him as a god unknown,
And understood no better than before.

—Stanton Coblentz

Acknowledgements

In the completion of this book, the author owes a debt of gratitude to many people. I wish to thank all of them here, though I can mention the names of only a few.

Putting first things first, it is fitting to express my gratitude here to the first man in chiropractic—Dr. B. J. Palmer. It was due to this great man's vision as far back as 1910 that the first research began into the comparative accuracies between palpation and spinographs. Out of this research came findings that palpation alone was in error in 85 per cent of the cases. Because of B. J.'s pioneering, X-ray now is taught in all chiropractic schools, and is in universal use by chiropractors.

Next, the PSC faculty—particularly the Principles and Practice division; also the personnel of the X-ray Department for their cooperation and encouragement.

Gratitude is expressed to my co-partners, Dr. Don Kern and Dr. M. C. Anger for their sincerity, ability and valuable service in the preparation of this text.

Also to Otto Schiernbeck, and the late Otto Schweinberger for their suggestions and assistance in preparing the electrical and optical material.

And to the Fisher X-ray Company for its assistance in the electrical and X-ray technicalities, and for many illustrations in this manual; and to my capable technicians Wylma Schroeder, Alice Hutchinson Spaulding and Lela Carrel for their tireless efforts in helping with illustrations.

I am indebted to my friend Paul Mendy, for his help in editing this book; to my secretary, Mae Ferguson who, from my scribbled and printed notes, produced a beautiful and accurate manuscript, and to Min Rogers for her invaluable aid.

To these and many others I shall be unceasingly grateful for their part in the making of this book. All have assisted as only true friends could.

Foreword

Here, the author has attempted to organize, as clearly as possible, all the new technique and procedure in chiropractic spinography which has been worked out in the X-ray laboratories of the Palmer School of Chiropractic. Other definite X-ray procedures in the various phases of X-ray are included.

The information contained herein is based on the actual results obtained after 36 years of extensive scientific research and experimentation, involving the use of many thousands of films and cases.

This volume takes the spinographic student through the entire spinal column. No matter what his desires may be in the practice of chiropractic he will find this work of value in every respect.

It is anticipated that the knowledge contained herein will be of value, also, to all chiropractors and to all spinographic X-ray laboratories.

Such technical information and stereoscopic procedures should greatly assist the profession in its work. And if its contents contribute to an improved quality in the analytical value of all spinographs it will then have fulfilled its mission.

Preface

•

X-radiation is dangerous. Disregarding rules and safety limits, X-radiation can be injurious to the health of both the patient and the technician. Direct rays are harmful to the patient. There are no circumstances by which the spinographer in his work must submit himself to direct radiation. His problem is to protect himself from secondary radiation. This he can do by applying one safety rule: Operate the X-ray equipment from within a lead-lined booth.

Back during 1903 Dr. G. E. Pfahler of Philadelphia, Pa., then director of the X-ray laboratory of the Medical-Chirurgical Hospital, stated: "We must adopt every means possible for our protection."

Dr. Frederick H. Baetjer, M.D., of Baltimore, Md., and many others who were members of the American Roentgen Ray Society, made similar statements.

During 1920 I received the same sort of instructions in Chicago at the Victor Corporation from Prof. Germain, and a repeat of these same instructions from him again in Philadelphia in 1926.

The National Research Committee's report reveals that radiation absorbed from the natural background may be harmful, and that all radiation beyond that point is dangerous unless complete protective measures are carried out.

Although atomic waste, or fallout, is considered most dangerous at the present time, the population is more dangerously subjected to radiation from the X-ray tube. The NRC also reports that the average citizen of this country now receives at least the same amount of radiation over his entire body from X-rays as from the natural background.

The research group claims that too much X-radiation (measured in roentgens) in persons under the ages between 30 and 40 years, affects the genes and heredity, and also produces pathological conditions. These mutations may not

be limited to those who receive the radiation, but may be passed on to succeeding generations. The committee emphasizes that X-rays are usefully important and necessary in the doctor's practice, but they should not be made unnecessarily.

In "The Biological Effects of Atomic Radiation," the National Research Council of the National Academy of Sciences defines a roentgen as "the quantity of radiation, such that the associated corpuscular emission per 0.001293 grams of air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign."

A meter, similar to the light meter used in photography, may be used over or under the X-ray machine to determine the amount of roentgens developed in a particular exposure.

There is no reason for the competent spinographer to exceed the safety limits in his spinographic work—and I know of no one in the chiropractic profession who deliberately does. Should the patient have absorbed the limit and does not inform the spinographer—assuming, of course, the question was asked of the patient—the spinographer should not be responsible. If everybody carried some sort of identification showing how many X-ray exposures they have had, where, the dates of exposure and, perhaps, the areas exposed, much of the danger would be eliminated.

Practitioners certainly would not deliberately injure their patients or themselves. However, I suggest we all respect the findings of these research groups. Don't make X-ray exposures promiscuously or unnecessarily!

Information from the National Research Committee is available in "The Biological Effects of Atomic Radiation" and "Pathological Effects of Atomic Radiation" booklets.

Introduction

History of the X-ray dates back to the latter part of the nineteenth century. Since that time it has, indeed, been a struggle. Perhaps the first X-rays were produced by Crookes in 1875, while experimenting with a vacuum tube, although similar experimentations were carried on by Geissler in 1858. Then Professor Hattoff, about the year 1860, discovered that the luminous stream of electrical discharges in the Geissler tube could be deflected by a magnet. This fact had an important bearing upon the experimentations made by Crookes, Hertz, Leonard and many others.

The work of Geissler and Hattoff was followed, several years later, by the experiments of Crookes with high vacuum tubes. Using these high vacuum tubes he found that the luminous glow would disappear. This demonstrated that with such a type of tube there was a rectilineal radiation from the cathode which was a projection of particles of highly attenuated gasses at exceedingly high velocity. This rectilineal radiation he called the cathode rays or stream.

In 1892 Hertz and Leonard, experimenting with vacuum tubes and their cathode rays, found that the radiation from these vacuum tubes would pass through or penetrate many substances opaque to ordinary light. Also it would excite and fluoresce in crystals of platinobarium cyanide and so effect photographic plates.

In 1895 Professor William Konrad Roentgen, then Professor of Physics at the Royal University of Wurzburg, Germany, began experimenting with the Crookes tube. Investigations proved that the fluorescence was caused by the radiation which was emanated from the point of impact of the cathode rays against the wall of the vacuum tube. He further noticed that this radiation could neither be refracted nor reflected to any extent and that it was not deflected by a magnet. Hence, it was obvious to him that this radiation was different from the cathode rays

of Crookes. He called these rays "X" rays, probably because of the significance of the letter "X" in the mathematical formula. Using photographic plates protected from ordinary light, Roentgen was then able to obtain with the X-rays, shadow pictures of metallic objects.

In 1895 he communicated his discovery to the Physical Medical Society of Wurzburg, Germany. This communication was published immediately all over the world. The same year in which Professor Roentgen discovered the X-rays, D. D. Palmer discovered chiropractic.

The author, at this time, wishes to take the liberty to wander back through the years of 1905-06 when he began his acquaintance with X-ray procedure. At that time more concern was being taken with the darkroom end. Having some boyish photographical and electrical knowledge, and being of a somewhat mechanical mind, he was permitted to tinker with an X-ray machine and later develop X-ray plates for a medical man. He was then employed in a photographic establishment, working nights after school and Saturdays. The actual picture taking he, of course, did not do. But how well he remembers the type of X-ray machine and how he now appreciates our modern equipment of today.

Machines of that day were of the static type with gas tubes which one had to coax along, so to speak, by continually engaging and disengaging the X-ray switch. Thus one attempted to force through the tube a certain amount of current until its resistance was such that a specified amount of current would pass through the tube. This procedure was usually a tedious one and even then one could not be certain of the correct amount of current used. Naturally, the quality of pictures was not the best.

At that time machines were very noisy when the current was passing from one terminal to another. X-ray work then practically consisted of fluoroscopic examination, and extremity work. Occasionally the hand fluoroscope was used, but nothing had been done with spines or deep tissue.

Glass plates were used. The emulsion was placed only

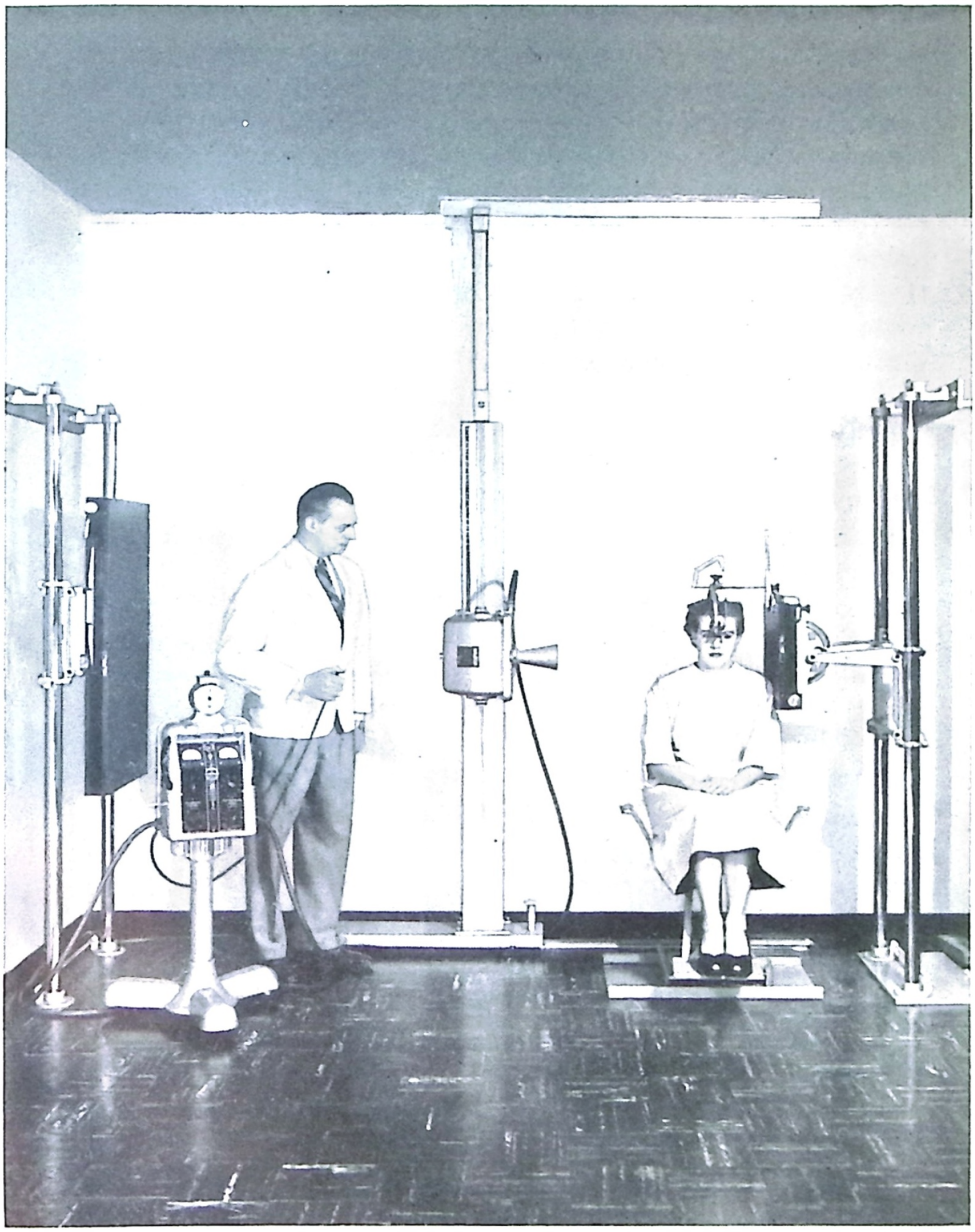


Figure No. 1
Model RB—H. G. Fischer & Co.
50-75 MA—96 PKV
Floor ceiling type.

on the one side which was to receive the exposure. The doctor determined the emulsion side, while in the dark-room, by wetting his finger and touching either side of the plate at the extreme corner. The emulsion side would be sticky. Then under the safelight the plate was returned to its black wrapping paper and placed in a cardboard holder for exposure procedure. The operator had to keep the plate from being fogged by ordinary light, and had to be very careful not to break the plate during the exposure or developing process. The tray system was used, and plates were submerged with the emulsion side up. Then a tuft of cotton, saturated in the developer, was lightly carried over the emulsion side to hasten the actual development.

As time passed, more efficient equipment was constructed and so better quality film produced. Soon, instead of glass plates came the X-ray film with its transparent base with emulsion on both sides. To further increase the speed of the film and to add contrast, an intensifying screen was constructed. Later, two screens were employed, each being placed in a cardboard holder which was backed with a thin sheet of lead foil.

Then came the cassettes in which the two screens adhered to the inside face and cover. And so today our exposures are made more or less instantaneously, and both detail and contrast prevail throughout.

In 1910 X-rays were introduced in the chiropractic profession by means of the spinograph—that is, a shadowgraph of the spinal column. This profession was, perhaps, the first to ever X-ray the spine or the spinal column—at least with any results. The word spinograph was coined by Dr. B. J. Palmer, the Developer of Chiropractic.

From that time hence, chiropractic and spinography, as a science, has been steadily increasing. Each year finds the Palmer School of Chircpractic carrying on more and more scientific research.

During the spring of 1930, Dr. B. J. Palmer discovered

the atlas and axis specific theory. During the fall of that same year this theory became a working principle.

By the spring of 1934, great progress was made in stereoscopic spinographic research and experimentation. Twelve months later definite conclusions were reached in regard to the atlas rotation. Sufficient depth, produced by the peculiar manner of procedure, made third dimension pictures whereby it was obvious that the rotation of the atlas did actually exist. This created the demand for more accurate cervical X-ray views and to satisfy this demand X-ray facilities were greatly improved.

Dr. B. J. Palmer not only saw the necessity for such scientific equipment but also proceeded to make such equipment which would facilitate the making of spinographs and spinographic stereoscopic X-rays. With this equipment he felt that accuracy and precision in revealing the exacting natures of the shifting of positions of subluxations following an adjustment would be attained.

Thus the desires of this ingenious, inventive and untiring mind not only created the demand for this scientific research, but also caused its scientific exacting precision equipment to be developed and in this development he spared neither time nor money.

In 1937 the vertex and base posterior procedures became a working principle.

Today Dr. Palmer's X-ray laboratories and his clinic are equipped with the most modern complete spinographic and stereoscopic chiropractic X-ray units, with accessories available. They represent the Utopia of Chiropractic X-ray equipment, and as much can be said for his equipment as can be said for him as a man among men—B. J., the developer and leader of our great profession.

X-RAY PHYSICS

The general scientific research during the latter part of the nineteenth century seemed to be the search for invisible light rays. And so it was towards this end that such scientists as Geissler, Crookes, Hertz and his assistant, Leonard, Roentgen and many others were working.

Geissler constructed a glass tube from which he eliminated much of the gaseous atmosphere. Then he found that when he connected both ends of the glass tube with the proper amount of electrical current, it would light up—giving off a sort of apple-green fluorescence. He explained the light this way: the passing of the current through the tube caused the molecules of gas to combat, breaking them up into even smaller particles which were called atoms and electrons.

Crookes, experimenting with the Geissler tube, constructed another tube of even higher evacuation. He observed a rather purple-colored stream when the current was induced, from the cathode to the anode or target end of the tube. He also noted that intense heat was produced at the anode end of the tube upon the impact of this colored stream, which he called the cathode stream, or ray, because it came into existence at that point. So due credit goes to Hertz and Leonard, although Hertz died and his assistant, Leonard, carried on this research.

In 1895 Professor William Konrad Roentgen of Wurzburg, Germany, while experimenting with cardboard and other bases coated with platinol and barium cyanide, noticed that when the current was passed off and on through the glass tube this prepared solution on its base fluoresced and dark shadows became visible. Further experimentation proved that under certain conditions on this so-called screen a shadow outline of the bony parts of his hand and a lesser shadow of the flesh could be observed.

It was then that he named these rays "X" rays because of their significance to the letter X in the mathematical formula. His discovery was then published and communicated all over the world, and the Physical Medical Society further honored him by naming these rays "Roentgen rays."

Although new ideas have been discovered and many changes have been made in the apparatus used in the production of X-rays, the actual laws pertaining to their production remain as Professor Roentgen found them.

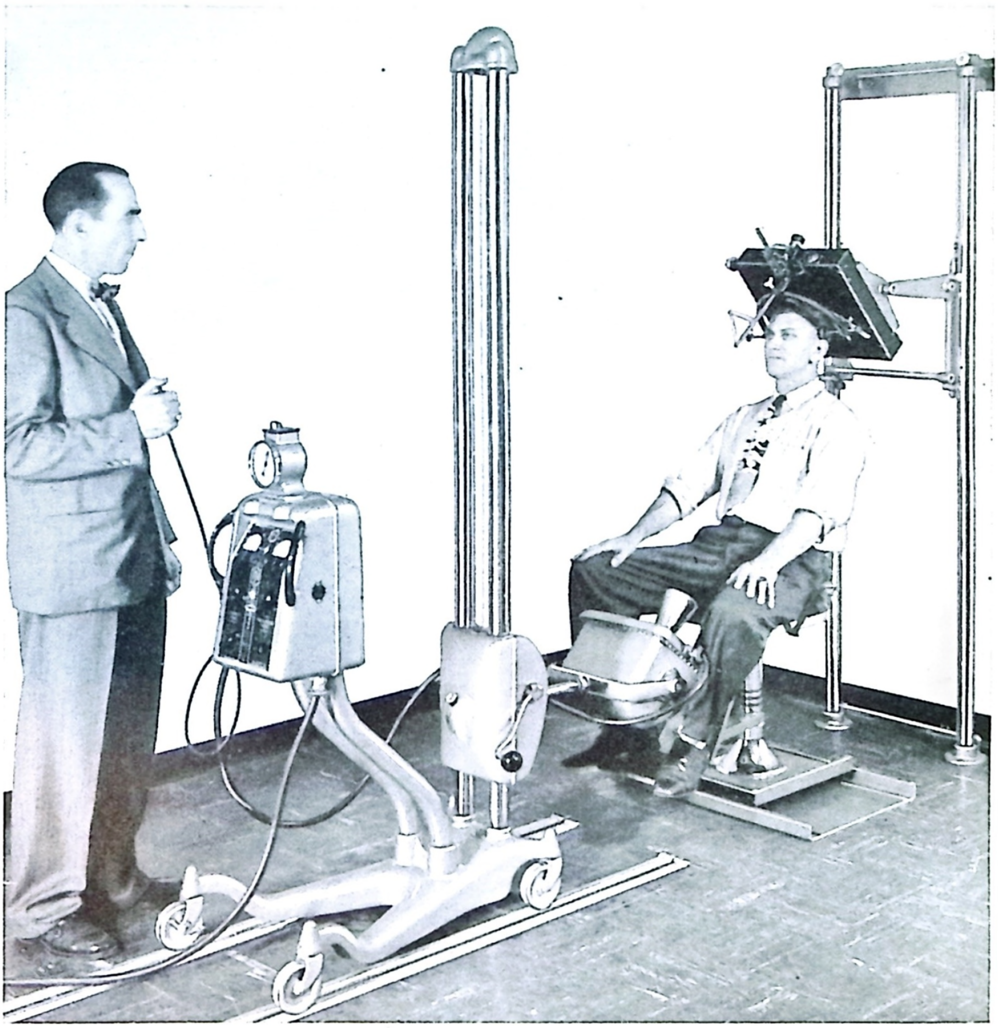


Figure No. 2
Model TCR—H. G. Fischer & Co.
30-50 MA—96 PKV

X-rays may be described as extremely short wave lengths in ether, produced by an electrical current passing through a glass-walled vacuum tube. They travel only in straight lines in an approximate angle of 15 to 22 degrees from the point of impact on the target. This angle is determined by the manufacturer of the X-ray tube. They can neither be deflected by a magnet, reflected by a mirror, nor refracted or polarized as our light waves; however this radiation does have some similar analogy.

The production of X-rays in the vacuum tube is the result of the projection of minute electrical particles, known as electrons, that are given off by the heated tungsten filament from the cathode to the anode or target end of the tube. X-rays travel many feet in an inverted "V" direction from their point of origin except where dense material obstructs, absorbs, or prevents their passage. A one-eighth inch of virgin sheet lead will absorb X-rays or radiographic energy. The same amount of energy will penetrate through one and one-half feet of plaster wall for ten feet beyond, and even more. On the other hand, one foot of concrete wall would be opaque to the ordinary radiographic rays.

When passing through bodies made up of different densities some of the rays that enter the denser portions are permanently cut out and a new distribution of intensity in the path results.

The wave length of the X-ray depends on the amount of voltage supplied. The greater the voltage, the shorter the wave length. The lower the voltage, the longer the wave length. This is commonly spoken of as hard and soft tube radiation.

The speed of the X-ray is said to be the same as that of light—186,330 miles per second. But the speed of the X-ray does not imply that it will travel great distances, since its penetrative value also depends on its wave length. The more resistance offered, the shorter the wave length must be. The presence of X-ray is only determined by the effects produced on a photographic emulsion and its ability to make certain chemicals or crystals fluoresce. On the

fluoroscopic screen, dense bodies are shown as dark areas, while on a photographic or X-ray negative they are revealed as light areas.

Various investigations have revealed that X-rays are identical in nature with light and electric waves, except that their wave lengths are much shorter than even the shortest light wave. Due to this extremely short length, their effect on matter upon propagation is quite different from that in the case of longer waves. Short waves are produced only by a change in the velocity of electrons taking place in intervals of time too short to be easily conceived.

In the production of X-ray there are four problems to consider:

1. To segregate electrons from atoms.
2. To give high speed.
3. To condense them on a small area.
4. To stop them with sufficient suddenness.

The Gamma rays of radium are simply rays caused by the sudden expulsion of electrons by the atomic break-down. They may be shorter or even longer than radiographic X-rays.

About the year 1900 Madame Curie found, when analyzing radium, that there were three separate and distinct rays present: Gamma, Alpha and Beta rays.

The term "ray" is used to designate two distinct types of phenomena. One refers to a projection of small particles by atomic disintegration, as that of the Beta and the Alpha rays. The other refers to the transfer of physical effects by the agency of wave motion such as light, Gamma and X-rays.

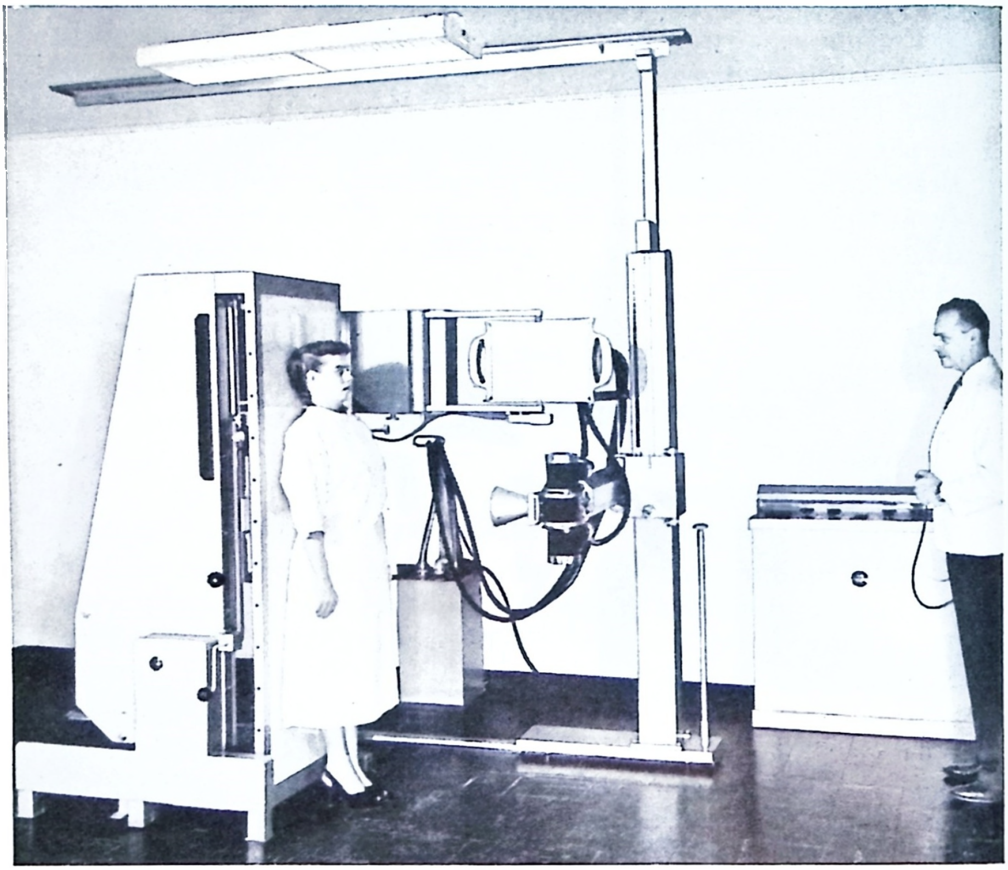


Figure No. 3
Mod. Multi-service—H. G. Fischer & Co.
100-200 MA at 100 PKV
Full rectification—all automatic controls
Rotating anode—double focus .8 fine-1.8 broad

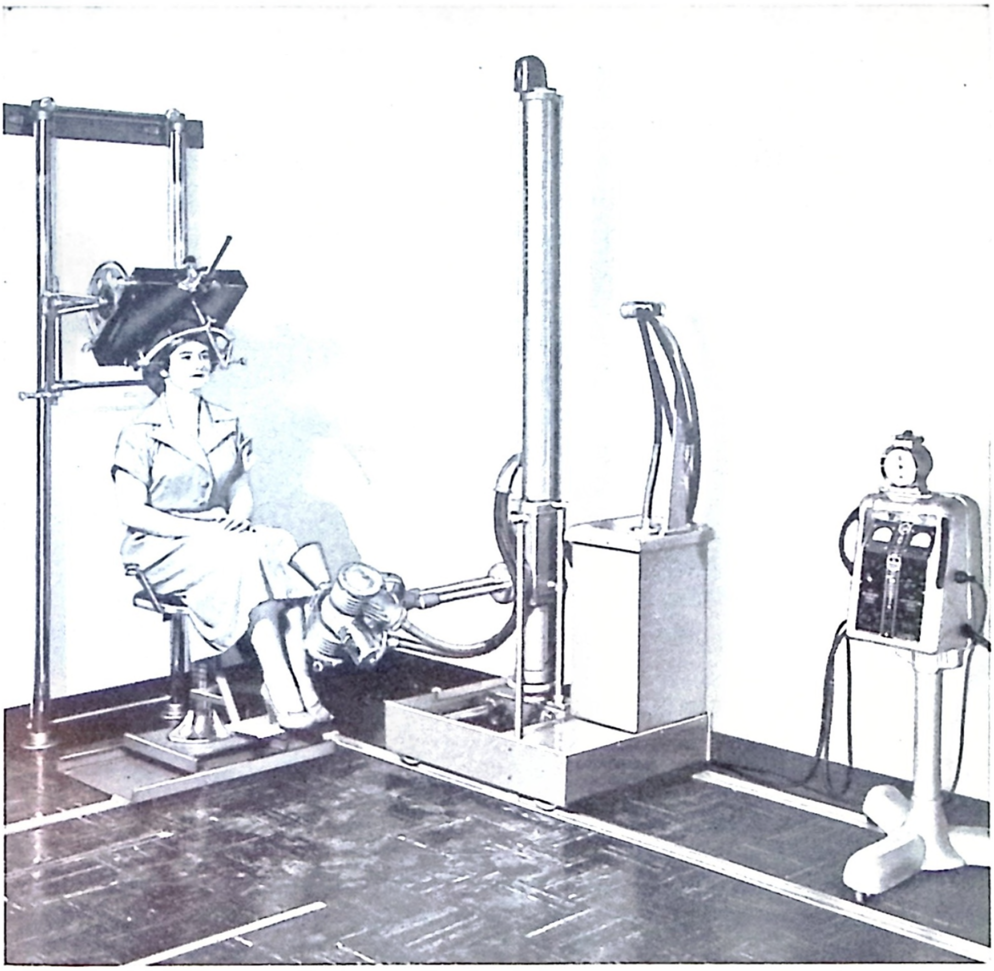


Figure No. 4
Model Multi-purpose—H. G. Fischer & Co.
100 MA—100 PKV
Self-rectification

Gamma rays are similar to X-rays in physical nature, except that some Gamma rays are of shorter wave lengths. The Alpha rays are known as the positive atoms—the Beta rays as the negative.

Science tells us that matter is composed of molecules; that molecules are composed of atoms, and that atoms are composed of electrons.

These tiny, minute electronic particles are sometimes spoken of as the cathode or Beta rays because they are a negative charge and attain an extremely high speed or velocity, while the atoms themselves are a positive charge.

CHAPTER 1

Terminology
Electrical and Machine

Alternating (AC) Current—is that electrical current which varies in sign, and progresses through both positive and negative terminals. In other words, it reverses its direction periodically or within every cycle.

Automatic Hand Timer—device whereby the exposure time may be accurately controlled and X-ray exposures duplicated. This device usually operates in fractions, from 0 to 12 or 15 seconds.

Bucky Release Button—up-to-date X-ray machines and bucky diaphragms are equipped with this automatic magnetic release. By making the proper control setting on the working panel and cocking the grid within the bucky diaphragm, one may press the release button on the panel to start the grid automatically. In about 1½ seconds the production of X-rays begin. Then stop or exposure time is finished, and in 1½ seconds the grid stops. Note: the grid travels the same distance at the end of the exposure as it does at the beginning of the exposure.

Circuit—is the complete path of an electrical installation.

Circuit-Breaker—is a device which automatically cuts out an over-load to the tube. It is a safety device and all machines should be supplied with one.

Conductor—any substance over or through which the electrical current travels, such as brass, iron, steel, water

and certain types of wood—particularly wood with a great deal of pitch in it.

Current or Electrons Travel Through the Tube—from cathode to anode.

Cycle—is the complete travel of the alternating current through its positive and negative valves. The ordinary commercial AC current ranges from 25-60 cycles. Practically all X-ray machines are constructed to operate on such a type of current.

Direct (DC) Current—is that which does not vary in sign or current and which flows or travels in the same direction at all times, from positive to negative terminals. There are comparatively few localities in the United States where only direct current is supplied; in foreign countries direct current prevails.

Filament Control—is a device, finely graduated, by which the technician may determine and regulate the amount of current passing through the X-ray tube.

Filter—refers to a piece of aluminum 1 mm. thick and approximately 5″ square. Its purpose is to absorb the soft rays which are the longer wave length, or X-rays of little penetrative value. These rays are injurious to the patient.

Foot Switch—is made to operate by foot pedal or the push-button. It connects, in the line, with the X-ray switch on the working panel of the machine. It may also be constructed to operate as a bucky release switch. This offers a more convenient method of operation.

Fuse—is a soft piece of metal alloy wire used in the circuit for protection from any abnormal over-load. It is a safety factor in the circuit, as it will melt or break under abnormal conditions.

Galvanometer—a sensitive instrument used to determine the presence, extent and direction of an electrical current.

Ground—from the X-ray standpoint this refers to a wire connection between the equipment and a water or gas pipe which is buried in the earth somewhere along the line. Its purpose is to carry off static electricity which the patient

would ordinarily feel during the X-ray exposure. Of course, the static would not injure the patient so far as a shock is concerned, but it may cause him to move somewhat, which would give the object a blurred and fuzzy appearance on the film. Such a film would be of little value, and would have to be retaken.

High-Tension Transformer—also called step-up or main transformer, increases the primary voltage to a greater capacity. It consists of an insulated iron box and coils with numerous turns of wire. All this is immersed in a high grade of transformer oil.

Inverse—in the tube refers to the current travel in the wrong direction. This, many times, has punctured a tube or it may produce a gaseous tube.

Line Drop—refers to the drop in primary or line voltage supplied to the machine. It may be the result of too small a size in gauge of wire, the length of run wire from transformer to machine, capacity transformer, or other loads taken from the same transformer. Ice machine, elevators, etc., often cause line droppage.

Low-Tension or Step-down Transformer—an electrical device which reduces the line voltage for heating the filament wire in the tube. The terminal voltage ranges from 6 to 12 volts.

Mechanical or High Tension Rectifier—constructed in cross arm, disc and the valve type. Its purpose is to change the AC current leaving the step-up transformer to a pulsating directional current. It is only necessary when operating machines having a greater capacity than 90 KVP and 30 MA. With units having a lesser capacity the tube makes its own rectification.

Milliampere Meter—is a device by which one may determine the amount of milliamperes to the tube. In the larger units, where an overhead aerial is used, such a meter is placed within the overhead aerial while in smaller units having no such aerial, the milliampere meter is installed on the control panel of the machine.

Motor Switch—usually a small push or pull button on the working panel of the machine. It cuts in the motor and revolves the rectifier. When using modern equipment it also automatically determines the polarity.

Non-Conductor—any material over or through which the electrical current will not travel, such as glass, rubber, and certain types of wood—particularly seasoned wood having little or no pitch in it.

Non-Shock Proof Unit—is an X-ray machine having bare or uninsulated wires from the high-tension transformer to either end of the X-ray tube. In this type of machine the tube is not usually encased.

Polarity Indicator—shows the direction of the flow of the current to the X-ray tube.

Pre-Reading Volt Meter—such a meter is connected on the low-tension side of the auto-transformer circuit and measures the voltage from each tap of the auto-transformer to the main transformer. In this manner various KVP may be actually determined and duplicated.

Remote Control Panel—is a control which is separate from the tube stand and which can be moved about, or operated, in a separate room.

Rheostat—is an electrical device made up of a number of turns or coils of resistant wire, and is used for offering resistance. It is placed on one side of the line between the auto-transformer and step-up, or the high-tension transformer.

Shock-Proof Unit—is one having insulated wiring or shock-proof cables from the high-tension transformer to either end of the X-ray tube. In this type of X-ray unit the tube is usually encased or immersed in oil.

Static Electricity—current at rest; an ideal condition in which the current is neither dynamic nor in motion.

Surge—a rapid change in the voltage which may, or may not, be read on the pre-reading volt meter. Such a condition may be the result of a high resistance, live circuit and a heavy, rapid application of a load. A faulty rectifying

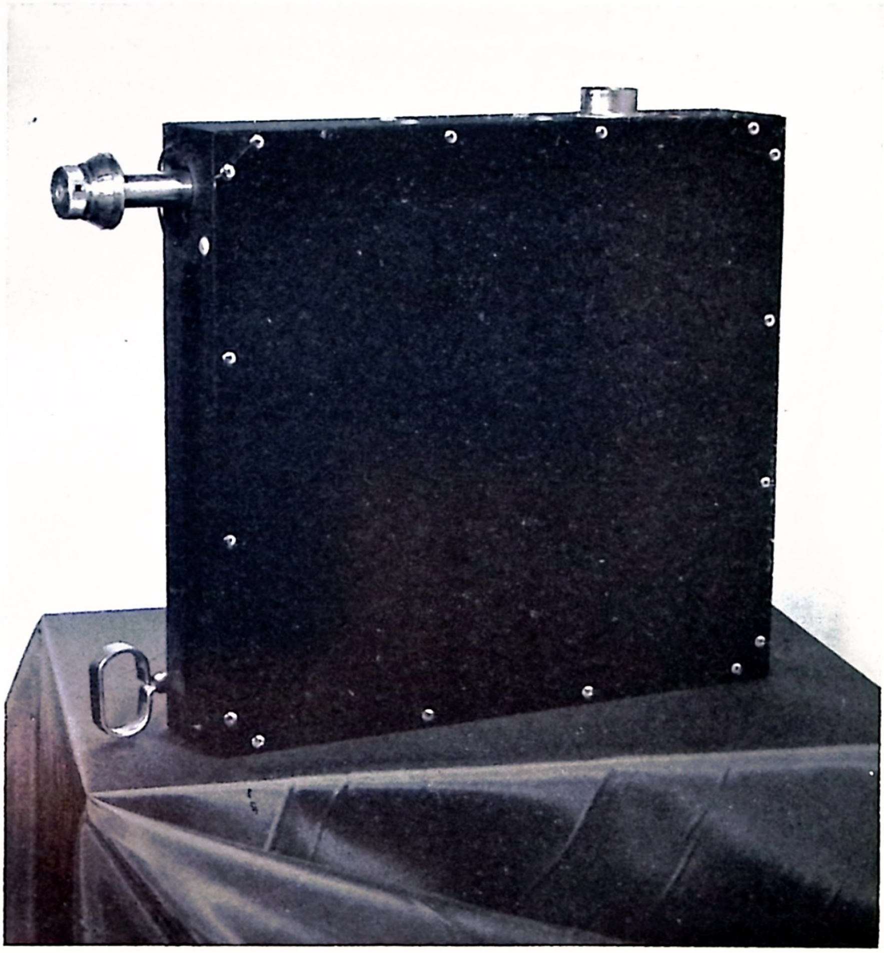


Figure No. 5
8x10
Bucky Diaphragm

Figure No. 6

8x10 Cassette with Intensifying Screens

switch or a ground leakage in the high tension circuit usually explains this condition.

Synchronous Motor—a motor timed exactly with the frequency of the alternating current. Its purpose is to revolve the high-tension rectifier.

Uni-Directional Pulsating Current—is rectified from alternating current by means of either a mechanical rectifier, valve rectification, or through the tube itself. The radiographic machines used today are of the mechanical rectifying type, self-rectification and valve rectification. The latter consists of two types: two valve half wave, four valves full wave.

X-ray Control Panel—sometimes referred to as the working panel. It is the section of the machine with dials and switches which is manipulated manually to produce a certain setting or given technique.

EQUIPMENT AND ACCESSORIES

Barium Meal—a powder substance mixed with a liquid and taken internally by the subject to be X-rayed. This meal will adhere to the walls of the stomach and intestinal tract, offering sufficient opaqueness to reveal on the film contours and certain lines of demarcation. It is also used in fluoroscopic examinations.

Dye—(Priodax or Telepaque tablets) used in gall bladder radiography. Taken in fruit juices after fat free meal the evening before the morning of the examination.

Bucky Diaphragm—made in either the curved or flat types. The flat is more generally used. Its purpose is to eliminate secondary radiation which is most detrimental to the X-ray film. It might be said that its main parts are the movable grid and the device for synchronizing the moving grid with the actual exposure time.

Bucky Grid (Referred to as a Movable Grid)—one of the main parts of the bucky diaphragm. It consists of a frame which holds thin strips of lead and certain types of wood. Its purpose is to absorb a greater amount of the angling

and secondary radiation. With proper alignment and correct procedures the lead strips will not appear on the developed film as grid lines.

Cassettes—a light-proof metal holder having either an aluminum or bakelite front, or face. Such a holder carries the film through the process of exposure, and of course, keeps the ordinary light from contacting the film. The use of the aluminum or bakelite face adds to or decreases, respectively, the amount of cassette resistance. Cassettes are made in various sizes to accommodate the various areas to be X-rayed.

Developing Hangers—can be had in various sizes to accommodate various sized films. They suspend the film and keep it submerged during the developing process. Such a device also prevents films from contacting one another during the process.

Fluoroscopic Screens—may be had in either the standard or hand types. When such standard type screens are excited by X-rays they fluoresce, producing a luminous glow when all ordinary light in the room is excluded. Such screens are used to examine movable parts of the anatomy to aid in reducing fractures, and for locating foreign bodies.

Illuminators—single, double or triple boxes with an opal blue glass front. They contain 75-watt blue bulbs or fluorescent lighting. These illuminators produce the proper light intensity to facilitate the analyzing of the finished X-ray negative.

Intensifying Screens—are of various speeds and are used in all types and sizes of cassettes to add contrast to the film, and also to shorten the actual exposure time.

Lead Cabinet—is an absolute necessity in X-ray laboratory equipment. It will absorb all secondary radiation which would ordinarily fog the unexposed film and give the finished film a muddy appearance, killing contrast. Such films would be of little analytical value.

Leaded Glass Goggles—refers to goggles worn during fluoroscopic examinations to protect the operator's eyes.

Such leaded glass goggles have the equivalence of at least a 1-16″ thickness of sheet lead.

Lead-lined Apron and Gauntlets—these accessories have the same equivalence of, and protect the operator's hands and body.

Stationary Grid—its purpose is to eliminate secondary rays and produce clearer films. The principle is similar to that of the bucky grid. It produces good results, and is more or less popular throughout the profession.

Protection Booth and Screen—such a booth is lead-lined and absorbs all secondary rays. It perfectly protects the operator. The screen, also lead-lined, offers approximately one-fifth protection and absorbs only rays from one side.

Stereoscope—a device for seeing depth on the stereoscopic X-ray film.

Turn Table—a unit to manually rotate the patient's body. The seat may be adjusted for a particular alignment. Its purpose is to make possible the precision alignment of the patient, tube, and film.

Vertical Cassette Holder or Model "R"—consists of an adjustable seat arrangement whereby the bucky diaphragm or the film itself may be adjusted to almost any conceivable angle. It may be operated stationary or moved about on a suitable track.

Virgin Sheet Lead—pure lead which contains no tin. Pure lead should always be used for protection. Secondary rays and ordinary radiographic X-rays will not penetrate a ⅛″ of sheet lead.

Wall Switch—a safety switch box connecting outside or incoming electrical line with cable leading to X-ray machine.

X-ray Cone and Cylinders—constructed of either lead or leaded-glass, and having the equivalence of ⅛″ of sheet lead. Its purpose is to reduce the radiographic field and add to the elimination of secondary radiation.

X-ray Films—X-ray negatives with double, highly sensitive emulsion.

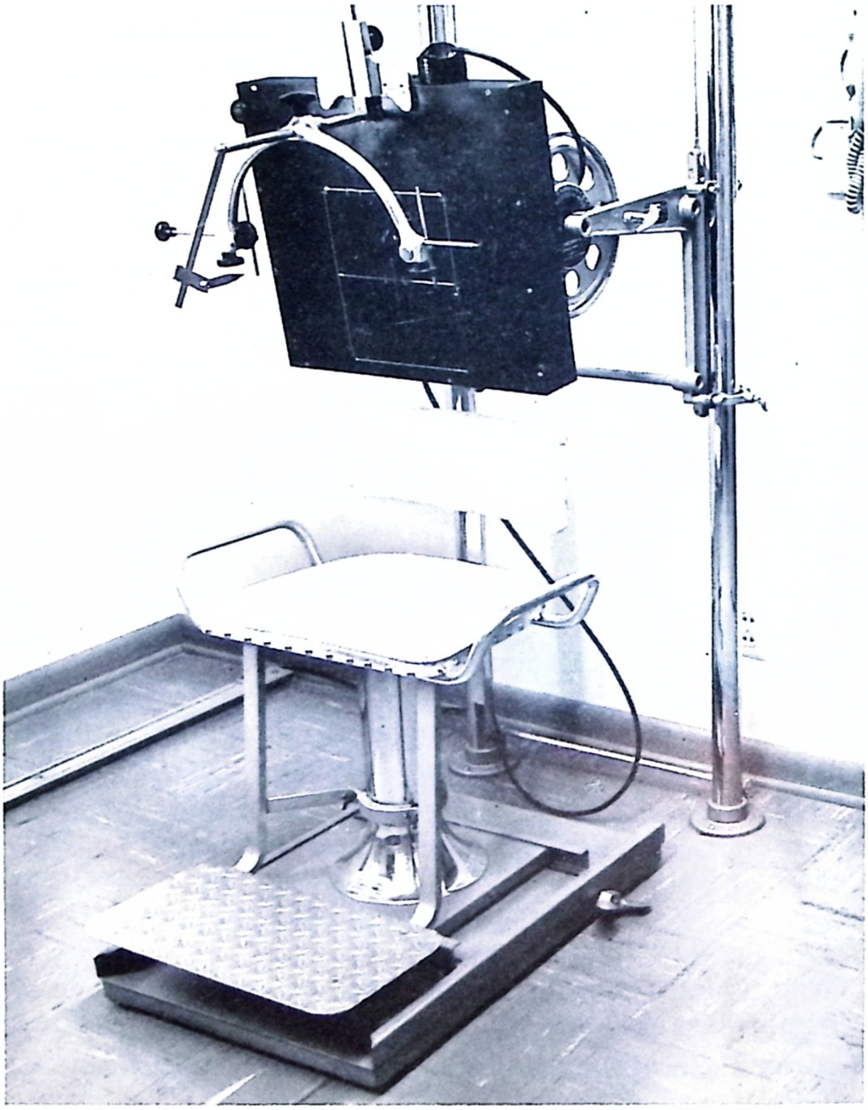


Figure No. 7
Thompson Turntable

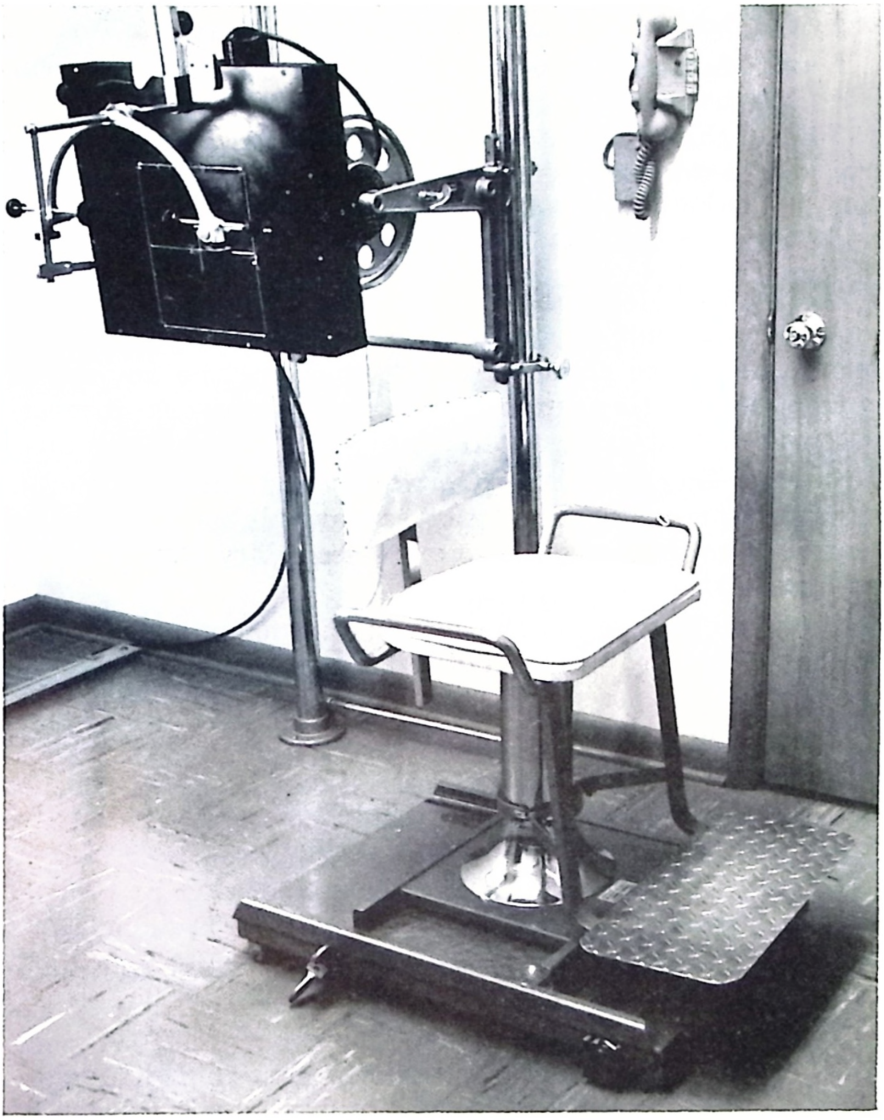


Figure No. 7-a
Thompson Turn Table
(At right angles to bucky)

X-ray Fog—refers to certain abnormal conditions appearing on the developed film. It may be due to secondary rays, ordinary light, developer or hypo stains, etc.

X-ray Markers—made up of lead letters and numerals. They are used to determine the right and left side of the patient, right or left stereo shift. Also used to connect the patient's name, serial number, date, and name of the laboratory with the film. All this is X-rayed on the film, and is a necessary requirement in legal action.

CURRENT, RADIATION AND EFFECTS

Ampere—a unit of current flow determined by an ampere meter. It is used commercially to measure the amount of current for lighting purposes, and for power work. It measures the current delivered to the filament of the X-ray tube.

Angling Rays—are those rays driven from an angle off the tube target. They are not as valuable as direct rays, inasmuch as they may cause more secondary radiation and produce distortion.

Complete Dosage—is the maximum amount of electrical current, measured in terms of milliampere seconds to which the patient is exposed while under medical X-ray treatment.

Current in Amperes—Electro-Motive Force in volts, divided by current in amperes.

Direct Rays—are the rays directed downward from the tube's target. They are the most valuable.

Dosage—refers to the X-ray technique used in medical X-ray treatment work.

Electro-Motive Force—is the voltage, or potential.

Hard Tube Technique—refers to a lesser amount of exposure time with greater penetration or more KVP. Such technique proceeds more instantaneously. Though a more contrasting film may be obtained with the soft tube technique, such technique does promote motion of the patient on the film. With the hard tube technique motion is more easily eliminated. Motion appearing on any X-ray negative makes the film of little or no value.

Kilo-Volt—is the equivalent of 1000 volts and is used as a matter of convenience only.

Kilo-Volt Peak—represents the peak of the voltage wave and is measured by a sphere gap. It is called high tension voltage. The term KVP (sometimes spoken of as PKV) is indicated on a Kilo-Volt-Peak meter. It provides a method of knowing the amount of penetration necessary in the X-ray work without testing the X-ray tube for each operation. This, of course, prolongs the life of the X-ray tube and eliminates a waste of energy. The peak K.V. value is 1.57 times the average value. There are three values in AC current:

1. Peak value used in X-ray work.
2. Effective value in commercial work.
3. Average value, seldom used.

Effective value is .707 times peak value.
Average value is .636 times peak value.

Kilo-Watt—is 1000 watts.

1 kilowatt x 1 hour=1 kilo-watt hour.

Milliampere—is 1/1000 part of an ampere and also is indicated by a milliampere meter. It is commonly spoken of as M.A. It is simply a finer graduation of measuring the current passing through the tube. The M.A. meter is often designed with two scales. The upper one reads 1 to 30 and the lower one 0 to 100 and even higher. This meter is placed within the overhead aerial or on the working panel of the machine.

Milliampere Seconds—is determined by multiplying the actual amount of seconds exposure by the number of milliamperes used. This is used as a safety measure or protection for the X-ray patient.

Milliampere Second Limit—is said to be 1200 milliampere seconds for the body, and 30 per cent less for the head, based on the actual distance from the tube's target to the X-ray film. One should never exceed the limit at any one time. However, these figures are debatable.

Ohm—is a unit of electrical resistance.

Ohms of Resistance—EMF in volts, divided by current in amperes.

Opaque—as applied to X-ray, means any material which does not allow the X-ray to pass through it.

Part Film Distance—distance from objects to film.

Radiograph—refers to any X-ray negative.

Rectification—there are three types: mechanical, self, and valve rectifiers. The latter consists of two types, 1 or 2 and 4 valves. Mechanical rectification is full wave and noisy. Self rectifier means a hot cathode tube rectifies its own current up to a certain unit of heat and is half wave. One or two valves is half wave and four valves, full wave rectification.

Secondary Rays—are produced when X-rays meet with resistance. Though traveling in straight lines they often explode and produce more rays. It is from this type of radiation the operator must protect himself.

Scattered Rays—also referred to as secondary rays.

Stray X-rays—are the result of electrons striking the target other than the focal spot. They have no useful purpose and are undesirable. These rays are eliminated by the tube shields.

Skin Distance—refers to the distance from the tube's target to the skin surface of the X-ray patient. This term is used in medical X-ray treatment work.

Soft Rays—are produced when using the soft tube technique. They are rays of little penetrative value and are very injurious to the patient, as they accumulate on the skin surface, and eventually break down tissue. Soft rays may be partially absorbed before reaching the patient by using a filter of 1 mm. of aluminum or a double thickness of chamois skin. The aluminum filter is preferable.

Soft Tube Technique—refers to a technique of a lesser amount of penetration with an extension of exposure time.

Spinograph—a word coined by Dr. B. J. Palmer which

refers, chiropractically, to a shadowgraph of the spine or spinal column.

Tube Distance—refers to the distance from the film to the target of the tube.

Volt—is the method of measuring the charge moving from one place to another. It is known as a unit of pressure or the potential or electro-motive force.

Watt—is the unit of electrical power. It is the product of one ampere times one volt; or watts equals volts times amperes. 746 watts are equivalent to one mechanical horse-power and one kilo-watt is, therefore, equal to about 1 1/3 horse-power.

X-rays—or unknown rays are produced on the impact of the cathode stream against the tube's focal point. They too, travel in straight lines. They are also called Roentgen rays, after the man who discovered them.

X-ray Burn—an internal reaction produced by too many X-ray exposures; that is, exposures aggregating a sum of milliampere seconds over and above the 1200 milliampere second limit. Such a condition is serious, and completely breaks down the tissue.

X-ray Dermatitis—a superficial condition wherein the X-ray exposures set up a skin inflammation. It is quite similar to the X-ray burn, but the burn is more serious. Blondes are more susceptible to this condition than brunettes.

Alopecia—refers to the falling out of hair due to too much penetration or exposure time in that area.

Protomeclein Salve and Butesin Picate Salve—have been recommended for the erythema dose or for X-ray burn.

TUBE

Anode—is the positive terminal or pole.

Cathode—is the negative terminal or pole.

Filament—is in the negative end of the tube. It consists of turns of fine tungsten wire of a high melting point. Its purpose is to furnish electrons.

Target—is a special metal of copper alloy in which the focal point or tungsten button is fastened. This is at the positive end of the tube. The angle of the face of this target varies from 15 to 22 degrees, thus allowing the X-rays to be driven downward.

Target Button—is constructed of the hardest known metal (tungsten). It is located on the face of the target, the anode or positive end of the tube, and receives the entire impact of the cathode stream. From then on, X-ray becomes a reality.

X-ray Tube—is a sealed glass bowl having a very high vacuum. It has two arms extending in opposite directions, with a target sealed in one arm and a filament in the other.

FILM READING

Ankylosis—fusing of two osseous bodies or points, and may be true or false.

Anteriority—refers to an abnormal forward direction.

Anteriority of Atlas—refers to its forward movement which usually increases the normal space between the odontoid of axis and the anterior ring of atlas.

Atlas Pivot (AP View)—refers to an abnormal position of atlas wherein the atlas moves anterior (forward) more than it rotates, causing the anterior transverse to assume a greater distance anterior from a horizontal line through axis than the posterior rotated transverse in relation to the same line.

Axis Pivot (Body and Spinous—AP View) (1)—body pivot is an abnormal position of axis wherein the spinous moves right or left of its own body (vertebra rotates) and the body remains in the median line or the body may have moved laterally in addition to its rotating. (2)—Spinous pivot is an abnormal position of axis where the spinous remains in or near the median line while the body swings low, counter-clockwise (left) or clockwise (right), with no rotation.

Complete Dislocation—refers to a spinal segment having slipped over both zygapophyses or mammillary processes.

Double Rotatory Scoliosis—a rotatory scoliosis combined with a compensatory rotatory scoliosis.

Exostosis—bony growth which may be either true or false.

False Ankylosis—is no more than a rearrangement of the original osseous structure.

False Exostosis—is an outgrowth of osseous tissue from the surface of a bone due to pathological changes in the bone tissue; usually the result of excessive heat.

Habit Scoliosis—caused by faulty position of the spine during a long period of time. It rarely produces pathological changes in the vertebrae. Yet there is usually some deformity of the bodies which produce a lateral curvature of the spine.

Kyphosis—an abnormal posterior curvature of three or more adjacent spinal segments.

Kyphotic Scoliosis—is a combination of posterior and lateral curvatures.

Laterality (AP View—Atlas and Axis)—refers to the side-slipping of atlas on the condyles, or the lateral position of the body of axis in relation to the median line—or the entire axis segment may move laterally, seemingly without rotating.

Laterality (AP View—Vertebrae Below Axis)—refers to a lateral position of a spinous process with the one above and the one below. Vertebrae below axis rotate rather than move laterally, except when moving with a curvature.

Lordosis—an abnormal anterior curvature of three or more adjacent spinal segments.

Lordotic Rotatory Scoliosis—is a combination of an anterior curvature—a rotation, and a lateral bending.

Nasium BP and Vertex Views—pertain to certain procedures in placing the head and the tube for spinographic

analysis. These procedures differ a great deal from former methods of spinographic work.

Partial Dislocation—means that the superior zygopophyses or mammillary processes have slipped past one another on one side only.

Plane Lines—refer to pencil lines drawn on the A to P cervical film to determine the median line and the point of wedge; also on the BP film to determine atlas rotation —on the lateral film to determine superiority and inferiority of atlas, and on the pelvis film to determine the superior ilium and leg deficiency. An actual superior ilium is a rarity.

Atlas Line (Lateral Cervical View)—draw line through darkened area of the anterior tubercle of atlas back through the center of the posterior arch. This may or may not divide the posterior tubercle.

Median Line (AP Regular Cervical View)—should indicate the center of the foramen magnum. Mark both inferior medial points of condyles. Bisect this distance. Draw horizontal or basic line through orbital area, usually at a point where the diagonal white line indicating the ossification of the sphenoid and zygomatic bones meet the lower margin of the orbital cavity, but must be at right angles to or level with the skull. Then draw the perpendicular or median line down at right angles to basic line through the point of bisection.

Perpendicular Line (Base Posterior or Vertex)—locate most upper or superior point of nasal spine and the tip of the external occipital protuberance. Draw line from one to the other. If malposition or anomaly is not present this line will divide the basilar process. Should head rotation or lateral head tilt exist, then the best procedure is to compensate for such variables by extending the perpendicular down through a point slightly right or left of the center of the basilar process, in accordance with the head rotation or tilt. Incidentally, the center of the basilar process should

be marked at its lower portion because there is less change in position at that point.

Median Line (Nasium)—procedure practically the same as AP regular, but points are often difficult to find. However, the alignment of atlas still must be measured in relation to the condyles or foramen magnum. The lateral tipping of the atlas on nasium film is determined by a line from points at the lower border of the posterior root of the transverse processes where it appears to join the lateral mass on the film.

Posteriority—refers to a backward movement of a segment relative to the one above and the one below. An atlas could not possibly move posterior unless the axis went posterior-inferior, nor could an axis move anterior-superior, unless atlas went anterior.

Rotation—consists of three or more adjacent segments rotated in the same direction. In other words, the bodies rotate one way, placing the spinous processes in the opposite direction.

Rotation of Atlas—refers to the atlas rotating, with one transverse and lateral mass moving to an anterior direction, while the opposite side moved to a posterior direction.

Atlas Axis Comparison—a simple, quick and accurate method of determining atlas condyle laterality, using the regular AP view in combination with the base posterior. The latter also proves atlas rotation.

Rotatory Scoliosis—is a combination of a lateral bending of the spine and a rotation of three or more vertebrae towards the lateral bending or convexity. The spinous processes will always be found to the concave side of the lateral bending.

Scoliosis—lateral curvature of three or more adjacent spinal segments, with spinous processes towards the convexed side of the curvature.

Static Scoliosis—is a lateral bending of the spine, adaptative to a short leg.

Misalignment—wherein one vertebra is out of alignment

with the one above and the one below. It may or may not produce interference with the flow of mental impulses.

Possible directions involved

Atlas—Five

1—Twist or rotation
2—Laterality
3—Superiority or inferiority
4—Anteriority
5—Lateral tipping

Axis—Four

1—Spinous right or left
2—Body right or left
3—Posterior inferior
4—Lateral tipping

Vertebrae below axis—Three

1—Spinous right or left
2—Posterior anterior
3—Lateral tipping

Sacrum—Three

1—Rotation
2—Posterior anterior tipping
3—Lateral tipping

Coccyx—Three

1—Laterality
2—Anteriority
3—Posteriority

Superiority of Atlas (Lateral View)—refers to the anterior tubercle of the atlas pointing upward and the posterior arch pointing downward. There may be a lateral tipping of the atlas whereby one transverse points downward and the opposite one upward, but they have no superior or inferior significance.

Superiority (Below Atlas—AP View)—refers to the lateral tipping of the vertebra. When one side tips high, the opposite side tips low. Superiority or inferiority if

present, is always listed on the side of laterality of the spinous process.

Total Scoliosis—a lateral bending with the spinous processes, following the convexity.

True Ankylosis—a pathological condition wherein nature rebuilds or adds to the osseous structure to strengthen it.

True Exostosis—is caused by excessive heat wherein there is a proliferation of bone cells, especially in the periosteum resulting in its ossification.

CHAPTER 2

Introduction to the Spinograph

The spinograph is a shadowgraph of the spinal column. When precisionally made it serves several purposes and is the key to skillful and specific adjusting. It determines pathology, fractures and dislocations of the spinal structures, as well as the misalignments; and in all its ramifications protects the patient as well as the chiropractor. Then too, it makes for better understanding between the patient and the doctor. When a spinograph is taken before adjusting and at the completion of the service, it will, in all probability, avoid malpractice actions.

There are, however, many variables revealed in the spinograph, though it may have been precisionally made. For instance, there is always some distortion present. This increases with non-symmetrical parts, anomalies or malformations and motion, and also when film and tube are not properly aligned. Motion is indicated by a blurriness on the film and might appear like a double exposure. Incidentally, a light muddy non-contrasty appearance indicates secondary fog, while a muddy, black appearance is both fog and over-exposure. The thin, light negative is under-exposed. Light fog produces a dark shadow across the film or its edge or edges.

Anomalies must be compensated for in any phase of spinography. Under certain conditions malpositions can be compensated for with some degree of accuracy but, of

course, it is always wise to retake the case, if possible, when there is more than a slight degree of improper placement. This is particularly true of the anterior posterior views of the cervical region.

It is absolutely necessary to continually check the equipment for vibrations as well as for proper alignment. This should be the first thing on the agenda each morning. Somehow, daily use of the equipment gets it out of alignment and often produces a vibration. Parts wear and become loose. So to tighten a nut or screw may correct a situation and eliminate motion or blurriness on the film which renders it useless.

Precision, proper exposure technicalities and darkroom procedures must be carried out to the fullest extent. A failure of any one of these factors may demand a retake. Spinographs, when not accurately made, are usually not read correctly. Though placement may be proper, if descriptive parts are not clearly visible the film is of no value.

Due to the variables in all spinographs, minute measurement to determine the amount of rotation, laterality or the line of drive, cannot be considered an accurate method of comparison. That which measures, say three degrees may be actually more, or even less. However, such a method, even though not scientifically correct, may be the means of keeping the chiropractor alert to the fact that he must be as precise as possible in his analysis and adjusting.

Lin-O-Drive—is an instrument with graduated discs and a pointer rod which makes possible a visible and more accurate line of drive which can be followed during an adjustment. The rod may be set for a rotated superior or perhaps inferior atlas. This means the rod may be tilted forward, backward or laterally.

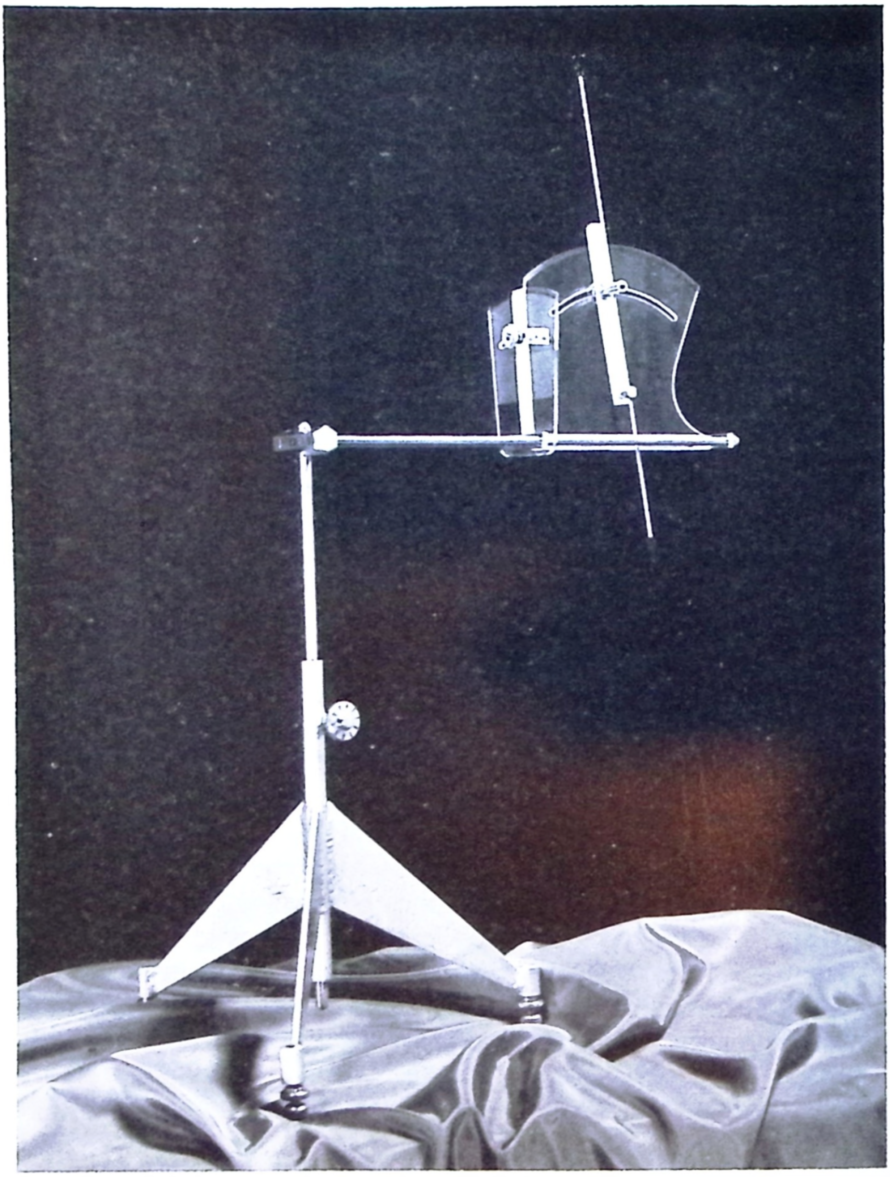


Figure No. 8—Lin-O-Drive

CHAPTER 3

The Spinographer

The successful spinographer must become familiar with four phases of his work. First, he must have the mechanical ability and be able to operate the equipment with precision and security. Secondly, he must know the spinal column, both normal and abnormal, including the vertebral articulations. Thirdly, he must completely understand distortion and body resistance, and the fundamentals of photography. Fourth, he must know how to arrive at a given technique.

The characteristics of X-ray technique consist of detail, contrast, density and distortion. Technique is a variable, and rather a personal thing. What might be satisfactory in one locality may not be in another. Further, no two technicians operate alike. Technique changes from time to time because of new design and construction of X-ray equipment, and because of the various types of screens and films which are constantly being made more sensitive to light, etc. So it behooves the chiropractor taking his own spinographs to continually strive to make better and more precision-like pictures.

Mechanical ability is a talent; it is a gift and a must in the chiropractor's and spinographer's work. Spinographic procedures are all mechanical. Not all persons have this natural ability. It takes some degree of this ability to operate any sort of machine. To operate the X-ray equip-

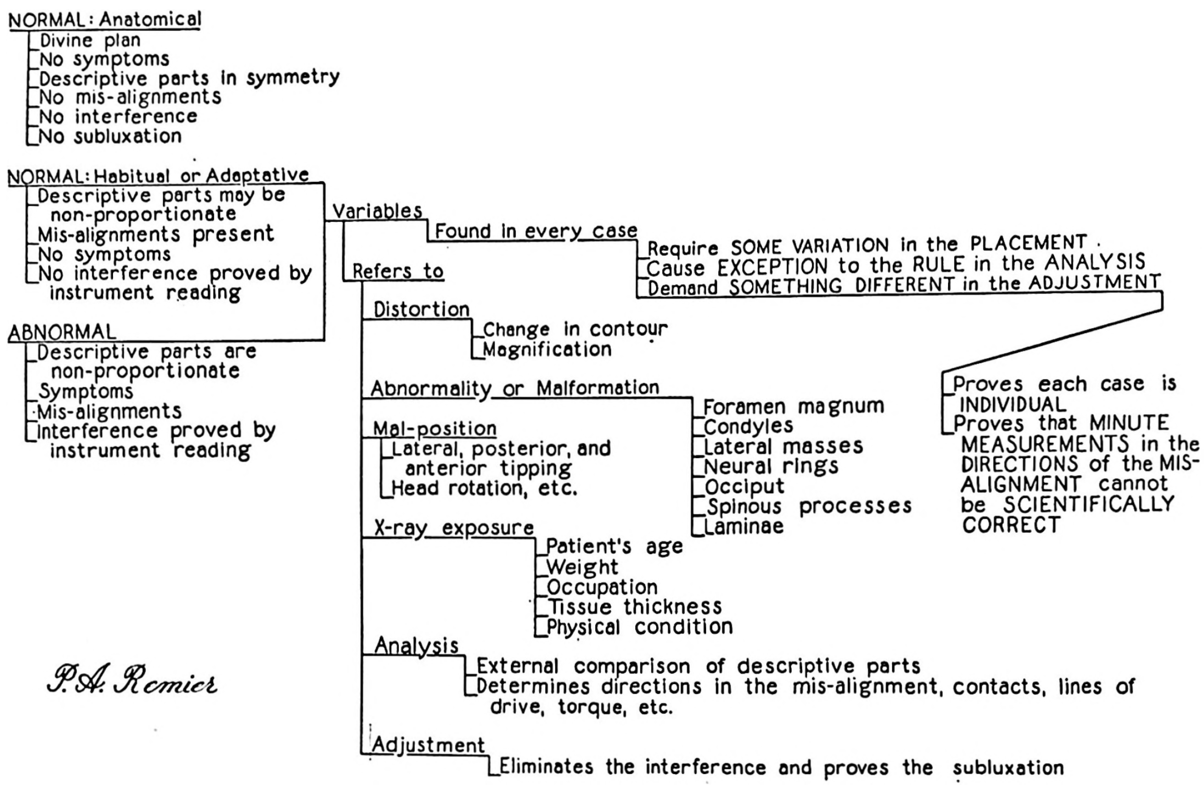

NORMAL: Anatomical
Divine plan
No symptoms
Descriptive parts in symmetry
No mis-alignments
No interference
No subluxation
NORMAL: Habitual or Adaptative
Descriptive parts may be non-proportionate
Mis-alignments present
No symptoms
No interference proved by instrument reading
ABNORMAL
Descriptive parts are non-proportionate
Symptoms
Mis-alignments
Interference proved by instrument reading
Variables
Found in every case
Require SOME VARIATION in the PLACEMENT
Cause EXCEPTION to the RULE in the ANALYSIS
Demand SOMETHING DIFFERENT in the ADJUSTMENT
Proves each case is INDIVIDUAL
Proves that MINUTE MEASUREMENTS in the DIRECTIONS of the MIS-ALIGNMENT cannot be SCIENTIFICALLY CORRECT
Refers to
Distortion
Change in contour
Magnification
Abnormality or Malformation
Foramen magnum
Condyles
Lateral masses
Neural rings
Occiput
Spinous processes
Laminae
Mal-position
Lateral, posterior, and anterior tipping
Head rotation, etc.
X-ray exposure
Patient's age
Weight
Occupation
Tissue thickness
Physical condition
Analysis
External comparison of descriptive parts
Determines directions in the mis-alignment, contacts, lines of drive, torque, etc.
Adjustment
Eliminates the interference and proves the subluxation
P.A. Remier

Figure No. 9

ment safely the spinographer must understand the hazards of electricity, as well as those of X-radiation. An X-ray machine in the hands of a novice can be a dangerous thing.

It is necessary to know the spinal column and its articulations like the ABC's, not only from the anatomical point of view, but from an understanding of the habitual and abnormal, too. The spinographer must realize there is a normal range of vertebral mobility in the twisting and bending of the body. For example, when the head rotates laterally the atlas rotates with it along with the axis, to a degree. When the head tips forward or backward the atlas tips accordingly. Then, too, there is usually some degree of anomaly throughout, so he must know that all misalignments do not produce vertebral interference.

To understand distortion and body resistance results in better placement and in deciding the exposure technique. Abnormalities increase distortion as well as the incorrect alignment of patient, tube and film. Distortion can be minimized by decreasing the field of observation, increasing focal film distance and compensating for the lateral curvature in placement. In other words, divide the curvature in relation to the median line on the film unless one is interested in a particular vertebra in the curvature. In that event the tube should be centered on that segment, including the 1st, 12th dorsal or 5th lumbar as landmarks. I might mention that distortion is always present, except at a point directly below the tube's focal spot. Spinal distortion increases with the use of the longer type film. It is increased by the misalignment as well as anomaly and improper placement. Distortion also refers to magnification which can be practically eliminated by a lesser amount of part-to-film distance (or object film contact) or increasing the tube focal distance.

Body resistance to the X-rays varies with certain physical conditions, thickness of tissue and muscular development. Two individuals may measure the same throughout a particular area. One will offer more resistance than the other. This is true of the spine of the aged, as compared

with the spine of the younger adult. The muscles of a man doing heavy work offer more resistance to the X-rays than the muscles of the fellow who sits at a desk all day. This accounts for light and dark spinographs. Better results would be obtained if the spinographer would consider body resistance and add or subtract to the factors that make up the exposure technique. If more current (M.A.) or force (K.V.P.) is needed and the capacity of the unit is so limited, the alternative would be less tube distance and more time.

Many still use the supine posture. However, placement is usually more accurate in the upright position because of the body weight in relation to the misalignment. The viscera levels off when using the supine posture, decreasing the resistance; when standing the viscera drops and creates more resistance. Spinal films taken in the upright position, however, are usually not as contrasty because the added resistance creates more secondary fog.

Processing the films is a constant and a most important phase in spinography. Films can be easily ruined in the darkroom. One should determine his best technique in the darkroom. Developing time should be the same if the proper temperature and efficiency of the solution are maintained. Should films develop too dark or even too light, correction should be made in the machine room rather than cut or lengthen the developing time. In other words, use the darkroom to know whether to add or subtract to the factors which make up satisfactory exposure technique. When solutions are not in use, keep them covered to prevent oxidation. When they begin to deteriorate, mix new. Repeating: full-time development should be made at all times.

Film definition, or detail, is controlled by the size of the focal spot (the smaller is more effective), part-film distance (which should be kept at a minimum), and focal film distance (which lessens distortion and secondary fog). Therefore, with the proper amount of KVP, current and time, detail will be at a maximum.

Contrast, the difference between two densities, is con-

trolled by kilovolt peak (the least amount is more effective), and greater tube distance which lessens secondary fog. Speed screens, certain makes of film, warm solution, cones, filters, grids, etc., to provide for greater contrast.

Exposure technique is primarily determined by a combination of milliamperes (current), kilovolt peak (electro motive force), tube distance and exposure time. Screens and films also play an important part. Super-speed intensifying screens require less time, though there is a tendency to lose some detail. Certain makes of film require less K.V.P. The manufacturer who is continually making film emulsion more sensitive to light is largely responsible for the many changes in technique.

Milliamperes are used as units of 10-20-30-100, etc. They are determined by the capacity of the equipment and the amount of density to penetrate at a given distance. So the intensity of radiation varies inversely as the square of the film distance. The relation of milliamperage and time are inversely proportional to the exposure time. Time and distance are directly proportional to the square of the tube distance. A simple method to determine kilovolt peak is to measure, in centimeters, the area or region to be spinographed; multiply by 2, and add 25 to 31. Always consider body resistance, the young and the aged. If the films used are extra fast, or if newly mixed solution is to be used, add less centimeters. Bear in mind, best results are obtained by using the least possible amount of kilovolt peak. Remember, too much kilovolt peak increases secondary fog which lessens film definition or detail.

In respect to all formulas and exposure charts—longer exposures, other things being equal, produces the most detail. But because of possible injury to the patient as well as the possibility of motion, spinographs must be made faster. In that event time is decreased; milliamperes and kilovolt peak are increased.

CHAPTER 4

The Value of the Spinograph

Constructive progress always results in better and greater success. We find this element of progress and advancement present in every successful industry, in every successful business, as well as in every successful science. Their very life depends on progress.

In the final analysis there can only be two steps—one forward, the other backward; nothing in between. In other words, to stand still also means to go backward, and this means failure. So to live, industry, business, and science must advance by taking that forward step.

X-ray is a science; chiropractic spinographic X-ray is a progressive science. It is quite young and, no doubt, many of its problems are still unfathomed. However, it is advancing, for it is going on and on. Each year sees another problem solved; and therefore, better and quicker results. This implies that forward, advancing, constructive progress, is gained only through continuous scientific research and experimentation. So the use of the spinograph in the practice of chiropractic is not a mere fad but an absolute necessity if one wishes to advance and to render the best possible service in getting sick people well.

The importance and value of X-ray to the profession, from an analytical standpoint, has been constantly increasing from the time of its discovery by William Konrad Roentgen (Wurzburg, Germany, December 28, 1895) up to the present time. Those who are engaged in this work realize its importance—its great importance—and they are

certain that this will continue as time goes on.

It might be said that the spinograph is a safety device to palpation—the one and only means by which mistakes and errors in palpation can be eliminated; therefore, its use is essential before an adjustment. However, to make that adjustment and to insure its correction, precision must be your procedure. **The precision spinograph is used to know the exact position of the vertebrae; to be able to make correct contact and line of drive. The Neurocalometer is used to locate the interference or point of pressure; to know when to adjust and then to be able to put into the adjustment the proper torque delivered at the proper time.**

Some of the older practitioners have remarked, "I do not need the X-ray. I have always obtained good results. I built my practice without it. So why should I undertake the expense and time necessary to operate such equipment?" Any practitioner who assumes such an attitude is certainly non-progressive. Palpation alone will, no doubt, hurt him individually, as it lessens his percentage of results and therefore his earning capacity; furthermore, it will lower the standards of his profession.

No matter how careful a palpator you think you are, no matter how efficient an adjuster you think you might be, without the spinograph you will make mistakes and perhaps, fail in many cases. It would be surprising to check back through records to see how high the percentage of failures really were. Did you ever stop to reason that one failure to get results means the loss of, perhaps, hundreds of cases? This is quite evident when due consideration is made of the patient's immediate family, his relatives and his immediate friends. It takes professional, ethical, and constructive advertising, with a good common sense argument, to sometimes convince and sell people chiropractic. On the other hand, it takes only a single failure to keep them from giving you an opportunity to prove its merits.

The eradication of only a few mistakes in your practice will more than pay for your X-ray equipment. It will pro-

duce quicker and more permanent results, thereby increasing your income. As stated above, it has been proved that many cases of errors in palpation are revealed by the spinograph. Today, in any spinographic X-ray laboratory there are to be found records of bent spinous processes, exostoses, ankyloses, anomalies, malformations of all kinds, as well as other conditions which palpation could not reveal. It is very essential and important to list these abnormalities before proper procedure in adjusting can be attempted.

I do not exaggerate in the least when I say that the majority of patients are afflicted with rotations, curvatures, scolioses or rotatory scolioses, which are often impossible to detect by palpation. Thus, to adjust a vertebra in a curvature, without first knowing that a rotatory condition exists, implies that the external force applied is going to be incorrect one way or the other.

Dr. B. J. Palmer once said: "There are just two main issues in chiropractic business—results and health to the patient, and satisfaction in those results and profits to the doctor."

Medics also believe that these principles are true in their profession, and so admit they, too, cannot see with their fingers. Dentists depend on the X-ray to locate defective and abscessed teeth so that extraction may be made only when necessary.

Without a doubt, the time has come when the chiropractor must be judged in the same manner. When insisting on a spinograph of every case, you are looked upon as being thorough in your work. This is particularly true from the atlas and axis point of view.

To get results means more business, so why should chiropractors not improve their service by spinographing every case, that they may see when and how such directions as side-slipping, rotation, etc., are causing the misalignment. Also, they can detect accurately the presence of pathological conditions, fractures, and dislocations. Seeing is believing, and X-rays, if properly made, never fail to reveal what there is to see.

Without a doubt, the X-ray is the keystone by which the progressive, up-to-date chiropractor can be recognized. Therefore, it behooves each and every chiropractor to have and operate an X-ray machine in his office. It will give him more confidence in himself. Too, it is much more convenient for one to have access to such equipment at all times, instead of having to refer one's patients to some other spinographer or practitioner who has X-ray equipment. Having this equipment in your office always has a decided psychological effect on your patient. Especially is this true when consulting prospective cases.

Because of the inability to correctly palpate a high or low condyle, (the anterior superior, the anterior inferior, and the anterior ring of the atlas, its rotation and the position on the body of axis), it becomes necessary to spinograph a lateral and anterior to posterior cervical spine to definitely decide the true specific position of atlas and axis with one another, and their relation to the condyles. This is also true of the spinal column below axis to determine bent spinous processes, exostotic growths, ankylosed conditions, long and malformed transverse processes, cleft spinous processes. All these make palpation very difficult, if not impossible.

There are a certain few individuals who cannot open their mouths widely. Some naturally have low occiputs, and others have permanent bridge work or large gold crowned teeth. These conditions make it difficult to always get good, clear, unobstructed A to P spinographs of the upper cervical region. In this event, an exposure from A to P through the nasium or nasal cavity may be of some benefit. These films also seem to have some merit as a matter of verification when deciding the wedge or side-slip of the ordinary A to P cervical exposures. Formerly, there seemed to be some doubt whether or not the slightest wedge or side-slip was actually true of the position of the atlas and condyles, or whether it was due to distortion caused by the angling rays, by misplacement, or by an

unnatural position of the patient during spinographic placement.

Years ago we talked of the advisability of spinographing in the upright position, but not until the atlas-axis specific idea became a working practice did we actually realize the importance of the upright, normal, relaxed posture. Experimentations were carried on, and conclusions were that the patient sitting up could, and did, assume a more normal, natural, relaxed position for spinographic exposures. Although the difference in the positions as revealed on the natural or flat spinograph films, using either prone, supine, standing or sitting postures, seldom revealed the opposite misalignment or subluxation, quite often it changed the general appearance of the spine on the film. This tends to increase or decrease the curvatures or change the position of the occiput as seen on the X-ray film.

During the summer of 1934 we again took up the idea of stereoscopic cervical work. After many months of scientific research and experimental work we produced sufficient depth on our upper cervical pictures to bring out the third dimension. This method and especially the base posterior view proved the rotation of the atlas. This is of vital importance to the chiropractor—for a large percentage of the atlas mis-alignments reveal atlas rotation as one of the major directions. It really is the first direction to be considered. However, there are many factors to consider, should one fail to obtain satisfactory results. Most important is the analysis; then the adjustment. Obviously such failures could be the result of not knowing what to adjust, or how to make the proper contact. Proper and precision equipment, the ability to correctly make and interpret the spinograph, proper contact and line of drive are of equal importance to obtain results.

Equipment and technical procedures are being constantly experimented with and are being improved to provide more information through the medium of X-ray films. And with this quality of radiograph or spinograph there is more information available, so this work becomes more important.

WHY THE CHIROPRACTOR SHOULD SPINOGRAPH EVERY CASE

1—It is a great aid in obtaining chiropractic results.
2—It promotes confidence.
3—The analysis could not be complete or correct without the spinograph.
4—It eliminates guesswork.
5—It creates interest among patients.
6—It reveals facts, chiropractically.
7—It produces business.
8—It completes a record of every case.
9—It reveals facts necessary in legal action.
10—It attracts a better class of patients.
11—It builds prestige for you in the community.
12—It is the proper way to explain chiropractic.
13—It enables you to talk more intelligently about a case.
14—It is the key to chiropractic success and health.
15—It reveals the vertebral misalignment.
16—It determines the correct point of contact and proper line of drive for the adjustment.
17—It reveals pathology.
18—It is the only means of knowing whether the vertebra can be adjusted.
19—It enables you to get quicker results.
20—Its use means more permanent results.
21—It should prevent you from adjusting the wrong vertebra.
22—It will often eliminate malpractice suits.
23—It will reveal conditions which symptoms cannot.
24—It is often the deciding factor whether or not to accept the case.
25—It is an investment—not an expense.
26—It is a scientific procedure.
27—It is absolutely necessary, particularly in atlas-axis specific adjusting.
28—It determines directions in the subluxation which are impossible to palpate or determine otherwise.

29—Chiropractic service is not complete without spinographs.
30—It means the difference between chiropractic success or failure.
31—It helps to eliminate the so-called "starvation period" that many practitioners go through.
32—It provides a quicker way to build a chiropractic practice.
33—It is being demanded today.
34—It eliminates unnecessary time in your office routine.
35—Its income makes it possible to arrange a better service.
36—It provides a safer and less expensive service.
37—It enables you to care for more patients daily.
38—It provides good interest on your investment.
39—It discloses the other fellow's mistakes.
40—It reveals trauma, anomalies and malformation of which the chiropractor must have knowledge before attending his case.
41—It stimulates the practitioner to greater activity because it eliminates any fear in giving the adjustic thrust.
42—It proves when palpation is in error.
43—It helps to build unity in the chiropractic profession.
44—It establishes scientific facts in research and experimentation.
45—It is the means of refusing a case when an adjustment might do bodily harm to the patient.
46—It is the only means of knowing how to adjust a particular patient.
47—It provides a method of taking comparative spinographs in chiropractic service.
48—It proves chiropractic.

CHAPTER 5

Essentials in Developing the X-Ray Laboratory

Essentials in developing the X-ray laboratory are the equipment, technical procedures, and their interpretations —all of which are of equal importance.

Equipment

The technician or spinographer must be provided with the proper equipment. This has much to do with the success or failure of his efforts. His progress and success may be made very difficult, even impossible, or it may be made very easy—according to the equipment he chooses. This equipment must be arranged in a practical manner to do precision work, and must have sufficient capacity to do the work undertaken. The machine must be capable of delivering the energy required; the tube must be of the proper type and of sufficient capacity to carry the necessary energy and to deliver the energy thereby developed.

Experience has shown that better results are attained in spinographic work by first employing the use of at least a 90 kilo-volt-peak 150 milliampere unit. Even greater capacity would be more satisfactory, because it is often necessary to do the work instantaneously. This is true when spinographing children, certain physical and organic conditions, as well as in stereoscopic procedures. To do the

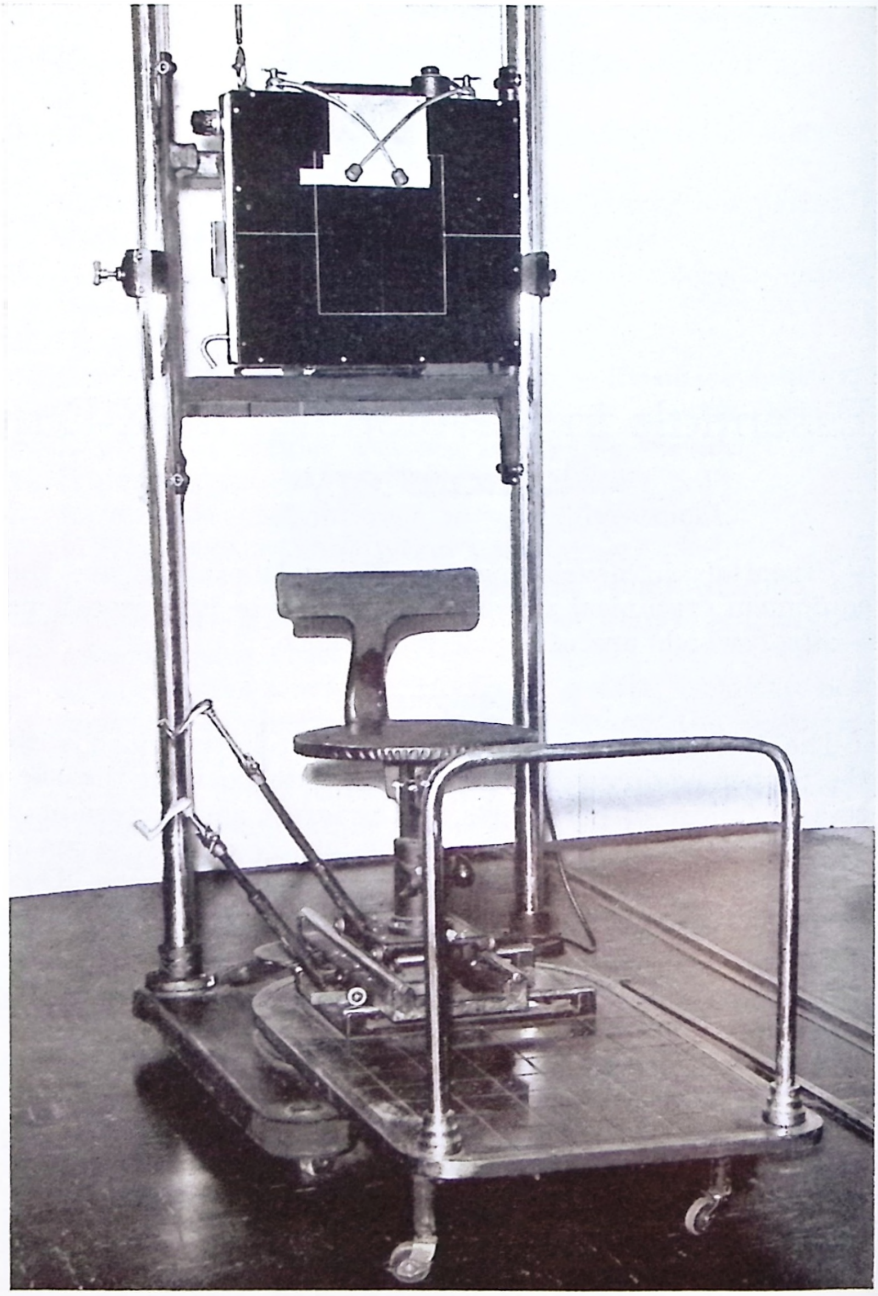


Figure No. 10
Model "R" Vertical Cassette Holder
with Turn-Table and Chair

work upright, preferably sitting up for atlas and axis work necessitates the use of the vertical cassette holder or tilt table which may be used in most any conceivable angle, and to which a small bucky diaphragm and head clamp may be attached. A turn table with seating arrangement should be added to the cassette holder so that proper placement of the patient may be manually made without

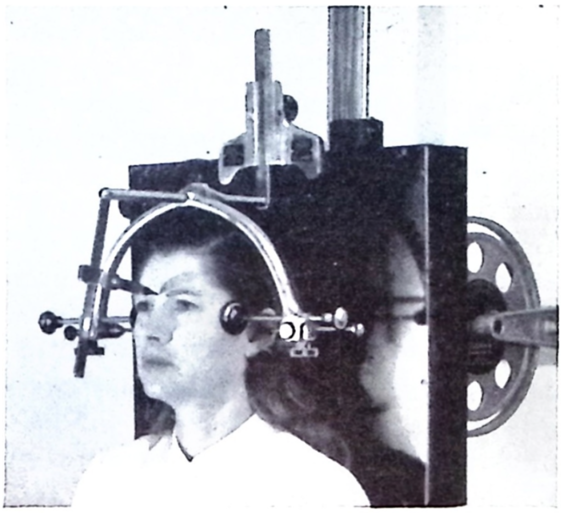


Figure No. 11

Thompson Head Clamp
Designed for precision work. Can be adjusted to any bucky diaphragm.

exerting the patient whatever, and still keep the case in a normal relaxed posture. Incidentally, such equipment performs most efficiently, and conveniently, in the placing of extremities for fracture, skull, or even dental work. A track is included in the precision method inasmuch as perfect alignment of machine, tube, and film or bucky diaphragm may be had.

Any attempt to successfully and consecutively stereo cervical regions or spinograph a pelvis, radiograph the chest, heart, or any other organ, of a 250-pound individual, using a small dental unit could only result in a complete failure. Likewise, to attempt to spinograph or radiograph heavy individuals with a fine focus tube would, in all probability, result in breaking the tube, as this type of tube lacks the capacity for such work.

It is very important that the unit be provided with the proper controls, for the controlling of factors; tube distance, time, milliamperes, voltage, and kilovolt peak or penetration. There is no difficulty in controlling the tube distance, for when once determined it ordinarily remains the same. The time factor is of more importance, especially when fractional seconds are used. With exposure from three to five seconds there may or may not be a small percentage of error with the use of the ordinary clock or watch. But whenever fractional seconds are used, an automatic timer should be applied to make duplicate exposures. In stereoscopic work this factor must be under definite control.

The milliampere factor necessitates the use of a graduated milliampere meter. With perfect outside line conditions, the milliampere factor should remain constant—once it is determined and fixed. However, should the milliamperage fluctuate, a stabilizer is the best known method of controlling this condition. Voltage, kilo-volt-peak or penetration is compensated and controlled by an evenly graduated auto-transformer. These are all parts of modern machines.

Technique

Careful, desirable technique requires considerable skill, and skill is something one cannot buy. It can be obtained only by continued practice and experience. Even then every one that studies X-ray may not make a successful operator or technician. No set rule can be applied accurately and successfully to determine the proper technique for any two individuals, particularly in different localities. Hence, height, weight, thickness of tissue, age, physical and even atmo-

spheric conditions, variations in current, peculiarities of machines and tubes, type and condition of films and intensifying screens, solutions and your own idiosyncracies are all of importance when deciding your technique.

There are many other factors which are likewise important. These are time, tube distance, milliamperage, voltage, placement, size of focal line or spot, lag, grain, contact and cleanliness of screens, speed and quality of films and the proper darkroom technique and procedure. All in all, there are many factors which make for a clean, clear cut, readable film.

Therefore, technique refers to the X-ray machine and to the accessories under certain physical conditions. The machine proper has to do with the controls which measure the amount of current and voltage for the exposure at a specified tube distance. The transformer increases and decreases the incoming current, which often varies, but will remain constant if a stabilizer is used. The accessories bring out the shadows, making the object visible on the film.

Amperage

An ampere is a practical amount of current intensity. Milliampere is one one-thousandths (1/1000) part of an ampere. The electrical current used in an exposure is always measured in terms of milliamperes (M.A.) such as 10-20-30-50-100-150-200, etc. Instantaneous exposures demand high milliamperage. Amperes produce the electrical burn.

Voltage

A volt is the pressure behind the current, otherwise known as the electro motive force (E.M.F.) One kilovolt is equivalent to 1000 volts. Kilovolt peak (K.V.P.) includes the peak of the wave. In radiology, the term "kilovolt peak" is used instead of voltage. So to express the amount of kilovolt peak in the exposure, such figures as 50-68-72-78, etc., are used instead of 50,000, 68,000, 72,000, 78,000 volts. Voltage produces the electrical shock.

The production of suitable films often presents a diffi-

cult problem. As has been pointed out, the very first requirement is complete up-to-date equipment, used with skill and accuracy. Next to consider is the purpose of the X-ray picture and the region of the patient to be exposed.

Then the position of the object must be determined in order to get the best possible results. Sometimes it becomes necessary to make a second or third exposure, changing positions each time until the proper one is found.

Finally comes the correct machine technicalities to be used, referring now to the exposure time, tube distance, milliamperes, and penetration.

The first exposure is usually more or less guesswork. Exclusive laboratories refer to this as a trial picture. Here is where experience plays a part. The more experienced the technician, the closer his work reaches the desired point.

Technique in radiology actually refers to the X-ray machine, transformer and the accessories—namely tube distance, intensifying screens, grids (stationary or movable) films, exposure time, processing, etc. The machine proper has to do with the controls, which measure the amount of current and voltage for the exposure. The transformer increases and decreases the incoming current and the accessories bring out the shadows, making the object visible on the film.

Exposure Time

Exposure time is usually indicated by milliampere seconds (M.A.S.), because of the various amount of milliampere combinations used in the exposure, of which idiosyncracies play a part. The amount used is determined by the capacity of the unit and tube, and the individual's idea of technique.

Some prefer doing the work instantaneously; others add more time to the exposure. Perhaps more time makes a more detailed picture, but there are two factors to consider: motion renders the film more or less useless and there may be instances when added time might be injurious to the patient.

In other words, a nervous patient might move in a 2- or 3-second exposure, but remain motionless during a flash exposure. Or he may have had the limit of milliampere seconds just prior to entering your office for spinographs, and if additional exposures aggregate many more M.A.S. in addition to what he already had, X-ray dermatitis, etc., may develop. Therefore, it is wise to attempt to determine if previous X-rays were taken, and when.

In the event recent exposures were made, you may want to wait a few days or even longer before X-raying again, or you might decide to X-ray immediately and make the exposures instantaneous which means high milliamperes and one second of time or less.

Milliampere Seconds

Milliampere seconds are determined by multiplying the number of milliamperes by seconds of exposure time. For example: 20 M.A. x 10 seconds=200 M.A.S. Other combinations are 50 M.A. x 4 seconds=200 M.A.S.; 25 M.A. x 8 seconds=200 M.A.S.; 100 M.A. x 2 seconds=200 M.A.S.

The milliampere second limit at any one time is approximately 1200 for the body, and 30 per cent less for the head, based on a 15-inch skin distance. However, some authorities now claim as low as 12-inch distance.

Kilovolt Peak

The amount of kilovolt peak is determined by centimeter measurement. One centimeter=0.3937 inches, or slightly more than 1/3 of an inch. If the area to be X-rayed measures 20 centimeters, an old custom is to double the measurement and add 31. For example, 20 C.M. x 2 plus 31=71 centimeters.

However, if screens are efficient and solution new—together with the fact that films are becoming more sensitive—add 26 or 27 instead of 31.

As previously stated, some thicknesses are more dense than others so the rule will vary to some degree. However, contrasty detailed films are only produced with the least

possible amount of kilovolt peak at a greater tube distance. For cervical views, the average amount of K.V.P. used with bucky diaphragm and high speed intensifying screens, should range from 58 to 74 at 60 inch tube distance.

Electrical hazards must be respected, as well as the dangers from X-radiation. Amperage—not voltage—causes the fatalities. The effect is primarily upon the heart, although other conditions may be produced such as acute high blood pressure and muscular convulsion of the thorax and diaphragm.

Never attempt to directly grasp anyone who might be in contact with an electrical wire. To do so might be suicide. Make every effort to free him by shutting off the current or, using some non-conductor like rubber, or dry wood, try to pull the victim away or break his hold. If necessary, call a doctor and apply first aid.

The modern X-ray machine is shock-proof, which means the cables from the transformer to the tube are sufficiently insulated to protect both the operator and the patient. However, these cables must be respected for a short could develop and be dangerous if one came in contact with them.

The oil in the transformer should be checked much like the battery in your car. Lack of oil might cause the transformer to burn out, and that would be an expensive experience.

Tube Temperamental

The X-ray tube is temperamental. Don't ever use it beyond capacity. It punctures and breaks easily, so handle it carefully. It is another expensive item, to say nothing about the inconvenience caused by a tube failing to operate.

Keep all unexposed films in a lead-lined storage bin in a cool, dry place, if possible. When not protected by a lead bin they become liable to secondary fog. If kept in a hot, damp place the emulsion becomes sticky and will ruin the intensifying screen.

To have access to most any exposure chart is an advan-

tage even though it doesn't always produce a satisfactory picture. It is something to start with, and if results are not gratifying the technician should know what to do to make the second exposure correct. Most hospitals and X-ray laboratories make a trial exposure to know what to do to produce the type of picture from which they desire to make their diagnosis or analysis.

Suitable Technique

A technique suitable for the spinal structures of one individual may not be satisfactory for another even though they may weigh and measure about the same. One may be of the athletic type with muscular development or thicker osseous structures, which increases resistance to the X-ray and usually demands an increase in K.V.P., or perhaps exposure time—and of the exceptional case when there is not sufficient current capacity, a decrease in tube distance may be an advantage.

In other words, to spinograph a severe case of hydrocephalus or even an extreme case of the giant head type, some practitioners might find it difficult because they do not have a machine of sufficient capacity. By decreasing the tube distance, a fairly readable film may be produced.

The Darkroom

With a few exceptions there is never sufficient emphasis placed on the darkroom. In a sense it is the most important phase of radiology. Films may be saved or ruined there.

Developing Process

Actually, the processing determines film quality. It is here that over- and under-exposure, secondary or chemical fog, etc., are first recognized. The darkroom is the place to work out or improve machine technique.

Darkroom equipment should be complete and proper for the size of films to be processed. Solutions and films should be purchased from the same manufacturer. Solutions should be kept covered when not in use to prevent oxidation. A 68° temperature should be maintained as nearly as possible,

for a solution too hot deteriorates and softens the emulsion; too cold retards its actions.

If using fast developer, films should process a full three minutes. Using standard solution at proper temperatures, develop a full five minutes; at 65° develop six minutes.

After the standard solution has processed about 200 films, then develop all films six minutes. Good developer is an amber color and practically odorless. Outworn developer is dark with a strong odor.

Fixing Process

Fixing is the next step and must continue for a least 30 minutes. However, films must be rinsed before being submerged in this fixer, otherwise known as the hypo bath. After film has been in bath for about three minutes, it is safe to examine it in front of an ordinary light. But it must be returned for the designated time.

Fixing solution has a dark color. As it deteriorates the color becomes lighter and the odor stronger. Films not properly fixed will fade. Keep container properly filled and the films apart from one another while processing, to prevent a blank and discolored spot on the negative. A five gallon tank of solution should process about 400 8x10 films.

After films are properly fixed they must wash for 30 minutes in cool running water which circulates around the films. This is important to prevent films from drying greasy. If running water is not available, agitate or move them about rather violently in clean water for about five minutes. Unless films are dried in a regular dryer, the use of a fan will cause dust to accumulate on them.

Standardizing the darkroom procedures should require full development. Then the development becomes a constant factor. The arrangement of the different steps in machine operation to the point where films will develop a full three, five or six minutes will produce the best radiographic results. Incidentally, developing time also varies because of the different makes of film.

IT IS WELL TO REMEMBER THAT X-RAY TECH-

NIQUE VARIES BECAUSE OF THE PROGRESS IN ITS DEVELOPMENT, DUE TO CONSTANT RESEARCH AND EXPERIMENTATION, AND BECAUSE OF THE INDIVIDUAL HIMSELF AND, PERHAPS, HIS LOCATION.

Interpretation

The most expensive equipment, with ideal line conditions and perfect installation, combined with the efforts of the best technician available may not obtain results unless one is qualified to interpret or read the films. This is true from either the medical or chiropractic viewpoint. So the practitioner of either profession must be capable and sufficiently trained to make correct interpretations.

Film interpretation not only requires a thorough knowledge of the normal and abnormal structures, but also a knowledge of its application from an X-ray standpoint.

Technically, the equipment should always function properly, placements should always be correct. Then the clearer and sharper the film, the more information will be available.

An X-ray laboratory represents a considerable investment. It is the writer's opinion that when the essentials mentioned above are carried out, the laboratory will always prove successful from a financial standpoint. Also, there is satisfaction when one renders efficient health service.

CHAPTER 6

Summary of X-Ray Machine Operation

Though the principle and theory of X-ray are the same the world over, all machines do not operate the same. In other words, the various knobs and levers on the working panels of the different units are not in identical positions. Therefore, to become thoroughly familiar with one machine and its operation does not mean that one could step into a strange laboratory and begin immediate operation on another type of unit. However, with a little study or explanation one could eventually operate it.

I am not referring now to technique, such as the kilovolt-peak, milliamperage, tube distance, and time. I am referring exclusively to machine operation and manipulation.

May I repeat that all who study X-ray technique and operation, whether it be chiropractic, medical, industrial or otherwise, may not be successful. This is true in any field of endeavor. Chiropractically speaking, this requires mechanical ability which is a talent or a gift.

All X-ray manufacturers, when installing X-ray units and equipment, make certain tests in the practitioner's office. It is customary to instruct him how to operate the machine, help him take a few pictures and supply him with a technique chart. Then, with the foundation obtained in his X-ray course, he should be able to work out his own technique. REMEMBER, ALL WHO TAKE UP THIS

WORK DO NOT MAKE SUCCESSFUL SPINOGRAPHIC TECHNICIANS.

Make sure the X-ray unit including the chair is properly grounded to eliminate all static electricity. Otherwise the patient will feel a tingling or prickling sensation which may cause him to move at the beginning of, or during, the exposure. This would cause the film to be of no value and a retake would be necessary.

● When using a milliampere meter with two scales, the divisions may be changed by pulling a string attached to the meter, thus raising or lowering the scale so as to read the desired number of milliamperes. The lower scale usually reads 0--20; the upper 0--200.

It behooves the operator to attempt to control the milliamperage during the actual exposure. Regardless of the type of machine used, testing and setting of controls should be done before placing the patient.

● If using the bucky diaphragm, check its timing device, with the film or cassette properly placed. All bucky grids must travel a short time before the acutal production of X-rays begin; and then continue briefly at the end of the exposure to eliminate grid lines on the film.

● When controlling the exposure time with the automatic timer, set it for operation.

● If stereoscopic pictures are to be taken, check the proper tube shifts.

Instruct the patient to sit or lie perfectly still, as nothing will harm him.

While observing the patient through leaded glass—either from behind a protection screen or, preferably, from within a leaded booth—the technician should be able to operate the timer, and trip the grid. If the machine does not have a bucky release he may then have to operate without lead protection, which is not a desirable procedure.

It is always advisable to develop the films immediately after the exposure, instructing the patient to keep the same

position, as nearly as possible, until the films are developed. This procedure should take approximately 8 to 10 minutes.

Modern machines have a pre-setting meter which means certain settings indicated by it will produce certain combinations of K.V.P. and milliamperage without energizing the tube. Be sure the tube is free from dust. Allow a few minutes after the tube lights before actually producing X-rays, since if the tube is cold or dusty, a quick or heavy charge of current might break it.

● If using the automatic timer, set it for the proper exposure time. Otherwise push the bucky release button located on the working panel of the machine. This automatically starts the grid to travelling. Then the production of X-rays begins.

● When operating a double focus tube (of different focal width), select the desired focal line by throwing the switch in the proper direction.

CHAPTER 7

The X-Ray Transformer and Controls

It is generally conceded that a poorly equipped X-ray laboratory is not only limited to a certain class of work, but that such work often times cannot be relied upon.

The author well remembers when technical procedures were so vague—so inaccurate—that proper alignment or precision methods were unthought of. Only the image, regardless of any contrast or detail, was obvious. How could such work be dependable? But even today in our rank and file similar procedures are carried on. Perhaps this is because many of us are prone to stay home and do not assemble to learn of the different ideas which would keep us abreast of the times. The modern X-ray laboratory requires the use of complete, carefully designed precision equipment in order that the very maximum quality results will be obtained. Then either the direct or alternating current must be available. Direct current machines are in the minority perhaps the world over, as they usually have a lesser output than the alternating machine. This is due to being limited by the capacity of the rotary converter, which of course is required to change the direct current to alternating. This is necessary in the production of X-rays.

Direct Current—cannot be increased to a high enough voltage for X-ray requirements, the alternating current and the rotary converter are necessary. A rotary converter, large enough to make the direct current machine as effi-

cient in capacity as an alternating current machine is considered impractical because of its immense size and expense. The function of the rotary converter is to increase its speed momentarily, then to decrease the current with a corresponding voltage drop to the step-up transformer. If the exposure time is under a heavy load long enough to cause the speed of the converter to slow down, it will result in a drop in voltage.

The voltage to operate a direct current machine is usually 110 or 220 volts; 220 volts being more desirable. To avoid limiting its ouput, the size of the main line wires supplying the machine must be relative to the capacity of the unit and the distance from the pole transformer to the main line switch. For the ordinary radiographic machine the line is usually fused to carry sixty amperes. A number six or eight wire is usually of sufficient size for the larger radiographical machines for the greater the distance from the pole transformer to the main line switch, the larger the main line wire must be to decrease the line voltage drop.

Alternating Current—is most frequently used for the production of X-rays. It is usually supplied from your immediate power plant or transmitted from a nearby substation to a pole transformer which should be located as near to the X-ray machine as possible. Its voltage is comparatively high, amounting to 23,000 volts or more.

The action of the pole transformer is to step down the electrical supply to the value which can be safely used for the occupant's needs. For X-ray use, it usually transmits 220 volts. However, occasionally only 110 volts are supplied—the amount of voltage used for general household purposes. The pole transformer consists of a steel core with primary and secondary wire winding placed within a weatherproof box. The core is immersed in transformer oil. The transformer should be of sufficient capacity to permit the X-ray machine to create its maximum energy. An additional load necessary to operate elevators, ice machines, etc., should not be placed on a transformer sup-

plying X-ray machines, for there is the possibility of overloading and this would limit the X-ray output.

A fuse box with proper fuses should be placed within the main line, near the main line switch, for safety purposes.

A main line switch of the concealed type should be installed conveniently near the X-ray unit so that the current may be cut off when not needed. Should one attempt to do any mechanical work on his X-ray machine, he should first disengage the main switch.

Auto-Transformer—is a control device which reduces the line voltage and operates very efficiently. It is connected across the main line circuit to vary the voltage from the main line to the step-up transformer. It acts as a valve which supplies the amount of current demanded. It may be constructed with a single or double lever and button control. No doubt the control offers a finer graduation—that is to say, a more definite K.V.P. may be had. Its design is indeed important, as such a transformer has an inherent drop in proportion to the current passing through it. Naturally, the better the design, the less voltage leakage there may be. There are a number of equally-spaced uniformed voltage steps or connections to regulate the voltage, and each step produces the same electrical variation on the primary side of the main transformer. Usually this ranges from 50 volts up to the entire voltage of the incoming main line. Some of the older types of auto-transformers are graduated in only three steps—lower, medium, and high. Any further variation would be mainly in the exposure time itself.

The auto-transformer will not stabilize the current. The voltage drop through the auto-transformer is based on approximately 10 per cent of the line drop. If the auto-transformer button and indicator points to a number or step delivering 150 volts, the approximate drop would be 15 volts.

Rheostat—is resistance used to consume a part of the line voltage. It consists of either the coil or grid type, and

is placed in series (one on side of the line) between the auto-transformer and the step-up transformer. In the more modern equipment such a separate control is being eliminated. When used, however, its purpose is to limit the power delivered to the primary side of the step-up transformer for obtaining intermediate values of the primary voltage in connection with the auto-transformer. The grid type is said to dissipate heat more rapidly than the coil type. This permits a longer operation with less voltage drop. The rheostat is used very little as a control for radiographic purposes because the slightest variance in the milliamperage causes considerable change in the secondary voltage. Once the rheostat step is determined, it should remain there for all radiographic and chiropractic spinal purposes. When the auto-transformer is used, the milliamperage may vary over a wider range, with only the slightest change in secondary voltage.

Pre-Reading Volt Meter—in working towards a high standard, the scientific chiropractor created a demand for stereoscopic spinographic views and natural or flat graphs, taken before adjustment with subluxation, and after adjustment without subluxation, and then with intermediate check sets taken between. All this not only necessitated the absolute use of a posture constant— the essential of all spinographic sets of the same individual—but it also required a constant duplication of kilo-volt-peak, as well as the actual exposure time.

It then became necessary to use a meter constructed within the X-ray unit and connected in the auto-transformer circuit for measuring the voltage delivered by each auto-transformer step to the main transformer. This meter pre-reads the voltage value of each auto-transformer step as soon as the main switch of the machine is engaged. If one is using the motor type of unit, it pre-reads the voltage as soon as the motor switch is turned on, before the X-ray switch is closed. In this manner the kilo-volt-peak value may be pre-determined and duplicated. No doubt, there

are other methods used, but none quite as satisfactory as the one described above.

Milliampere Meter—gives an accurate reading of the current in milliamperage going through the tube. A milliamperage is 1/1000 part of an ampere. In X-ray work it is used as a more convenient way of reading this type cf current. Incidentally, different amounts of milliamperes are used in various techniques for the same region.

Polarity Indicator—in operating the X-ray machine it is understood that the electric current must pass through the tube from only one direction—cathcde to anode. This is determined by a polarity meter, when using the alternating current with mechanical rectifier. A device, known in electrical terms as a polarity commutator, is attached to one end of the motor shaft which supplies the current that operates the indicator or needle in the polarity meter; and thus it indicates the direction of the current to the tube. This commutator is so constructed that it changes the line voltage from an alternating current to a uni-directional one by stopping each alternating wave, or half cycle. In this way it prevents the high tension current from traveling across the tube in the wrong direction.

Either a primary reversing switch or the motor switch is used to operate this polarity indicator. The latter is most commonly used.

When starting the motor, if the indicator is found pointing in the wrong direction, disengage the motor switch; then immediately re-engage it. This procedure will force the indicator to point properly.

When using the self- or valve-rectification units, a polarity switch is not necessary.

Main Transformer—(otherwise known as the step-up transformer) increases the low voltage current to the required higher voltage. It usually ranges in operation from as low as 50 volts, up to and including 220—and sometimes even uses as much as 60 amperes. The maximum voltage of the smaller units is approximately 90,000, while that of the larger types will run as high—and sometimes higher

than—150,000 volts. Ordinarily, 90,000 volts, or 90 kilo-volt-peak, is sufficient penetration for any bone work. As a matter of fact, it is ample for almost any type of radiographic work.

The entire system in the step-up transformer is insulated and immersed in oil. The top of the transformer should be kept clean, and free from dust, dirt, and oil. Any oil leakage must be stopped immediately.

The oil lever should be examined periodically to keep the oil well over the top of the coils. This prevents possible shortage, and completes the expulsion of air. Inspection of all connections for tightness further aids in getting the best results.

Synchronous Motor—is one in which the speed is timed exactly with the frequency of the alternating current. It is the only type of AC current motor successfully used in operating the mechanical rectifiers, in order that rectifying elements be always in proper position with each alternation of the alternating current wave.

When only direct current is supplied, the rectifier is revolved by a rotary converter. This keeps the correct speed, and also changes the direct current to alternating, so that it will be increased to the desired amount by the main transformer.

If the motor does not synchronize with the AC frequency it will, in all probability, ruin the tube. Sometimes, however, the rectifier would prevent this. Such a condition may be determined by the polarity needle swinging from side to side.

Mechanical Rectifier—there are two forms of mechanical rectifiers—the cross arm and the disc type. Though the quality of radiation delivered is practically the same using either type, the former is the most popular. They both are operated by the synchronous motor. Their purpose is to change the high tension AC current leaving the step-up transformer to a pulsating direct current before it reaches the X-ray tube.

It is very important that the rectifiers are correctly

placed on the motor shaft, relative to the motor armature. If out of phase, the arcing between the rectifier contact becomes long, and results in the loss of tube current or penetration. Only machines carrying a capacity of over 90 K.V.P. at 30 MA necessitate the use of rectifiers; otherwise the tube rectifies the current.

Although X-ray machines with mechanical rectifiers are being steadily replaced with valve rectifications, it is necessary to briefly explain this type because there seems to be many such units in operation today.

High Tension Circuit—provides for the passing of the pulsating direct current from the rectifier through the milliampere meter, and indicates the amount of current going through the tube.

The overhead aerial and reels or shockproof cables carry the high tension current from the machine and deliver it to the tube. There are two terminals at the cathode end of the tube, and one at the anode end.

Filament Circuit—provides current with proper controls for heating and lighting the filament. The necessary voltage ranges from 5 to 12 volts. This current may be supplied from a separate transformer, commonly known as a filament transformer, which in reality is a step-down transformer. In the modern day equipment this voltage arises from a low voltage winding of the auto-transformer.

Operator's Control Panel—includes such controls as the main switch, the X-ray switch, bucky release button, and motor switch (if using the mechanical rectifying type), auto-transformer knob or knobs (referring to single or double control), rheostat knob or lever (if a rheostat is used), milliampere meter, kilo-volt-peak meter, pre-reading volt meter (meters have knob or lever controls), polarity meter and indicator (when not using the self- or valve-rectification unit), and pilot lights. Usually there are two plug recepticles for plugging in the automatic timer or foot switch.

Stabilizer—is sometimes added to the X-ray laboratory

equipment. It ranges in operation from approximately 5 to 100 milliamperes, and is made in two types so that it operates with either the mechanical rectifying unit or the rectifying tube type unit itself. It is connected in the secondary circuit of the high tension and filament transformer.

Its function is to maintain a steady flow of current through the X-ray tube—no matter what variations one may find in the line voltage. The stabilizer, once set for a given milliamperage, remains fixed, permitting only that certain amount of current to pass through the tube, unless othewise re-set for a different amount of current. The accuracy of such a device is said to be such that, upon one setting, it will deliver the same amount of current through any two radiator types of tube. Also it adds life to the X-ray tube where tube testing is necessary. It works similarly to a thermostat—no more, no less, when once set. However, it may be set for various milliamperage.

Most all of the larger exclusive X-ray laboratories are equipped with such a device because, throughout the larger cities, a fluctuation in X-ray current is indeed a menace. Incidentally, the stabilizer will not increase the milliamperage over and above the machine or tube capacity.

Automatic Hand Timer—can be used to great advantage in duplicating exposures, so far as time is concerned, although the use of such a timer may not be absolutely essential.

X-ray technique will possibly vary as much as 10 per cent or more in different localities, due to line variation or fluctuation, quality of screens, and the use of various types of tubes, etc. But a given technique, good screens and the proper darkroom procedure, without any line variation, will usually produce very good results in duplicating exposures.

CHAPTER 8

Calibrate to Standardize Technique

It has been the policy at P.S.C. to standardize machine technique. The primary object is to simplify, as much as possible, the spinographic work for those who desire to take X-rays of their patients. Where all machine technicalities are variable factors—that is, milliamperage, kilo-volt-peak, time, tube distance, etc.—it is quite difficult for the average person to calculate corrctely. This results in a poor film. And so it is with the majority of field practitioners who take spinographs of their own cases, as well as attend to the rest of the practice procedures.

It is possible for a technician who has specialized in X-ray, and who applies all of his time to this work, to make any or all of the technical factors variable. But it takes constant practice and much thought. It has proved the best policy to standardize technical factors of each type or film, for all patients. The varying factors usually are the kilo-volt-peak, and time. Of course there are exceptions, such as in the case of infants, in conditions of paralysis agitans, or in those cases where immobility for any length of time is impossible.

It is very difficult to give a technique that will be applicable for all machines, tubes and patients. Several factors enter into this: a slight difference in transformer, windings, different size focal lines and tubes, different makes of tubes—and too, there is the altitude and barometric

pressure to consider, as it seems to affect the quality of X-rays, condition of patient, etc.

Calibrating the machine and each tube eliminates any testing of equipment before use. And also, one knows just what a given setting will produce, so far as kilo-volt-peak and millamperage are concerned. However, this practice cannot be depended upon if you are having a great deal of variation in current.

This method is really a time and money saver and, naturally, obtains better results.

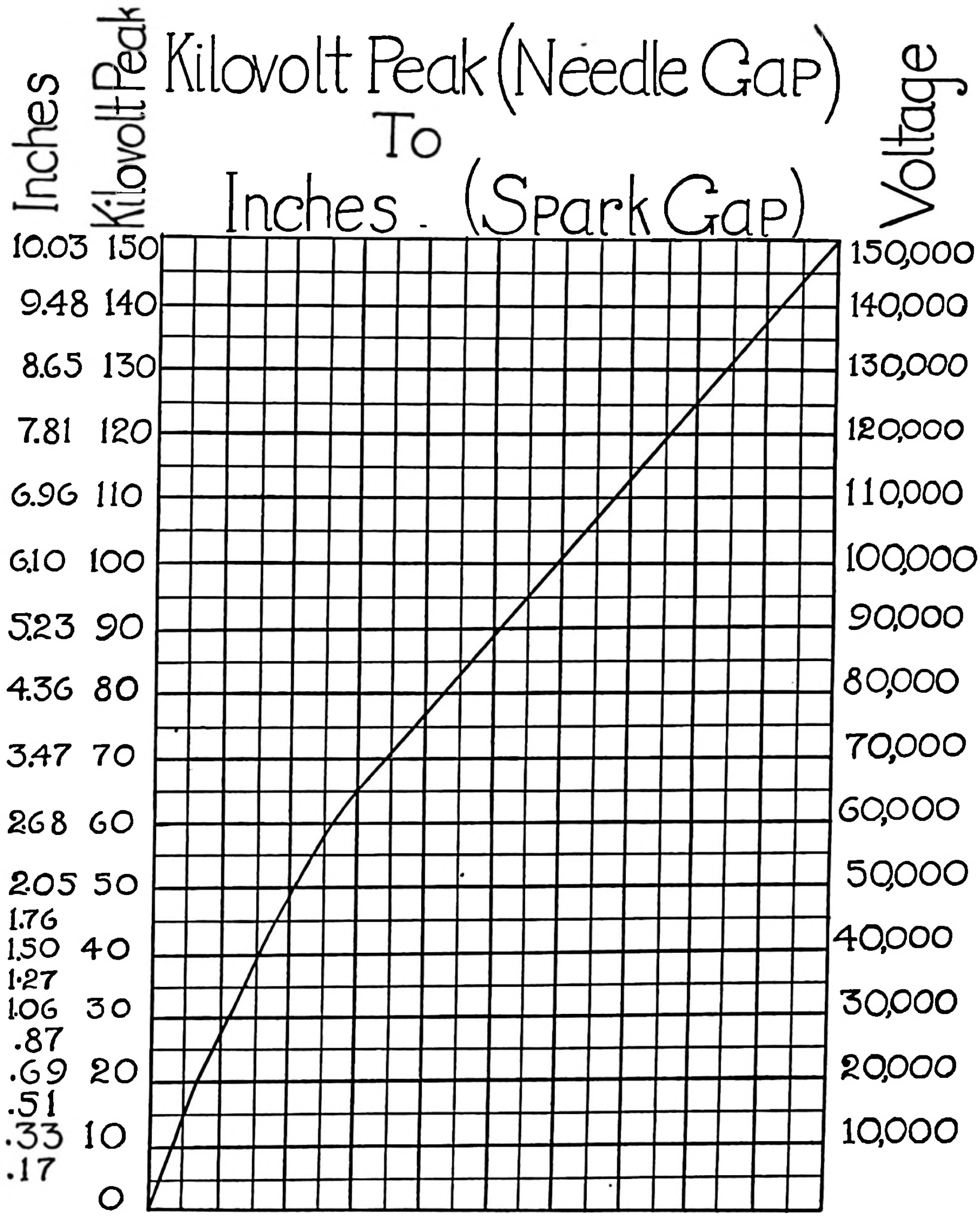
Sphere Gap—is a device for measuring the high tension alternating voltage across the terminals of the X-ray tube. It is said to be recognized as the only accurate instrument for the practical measurement of such voltage.

To check with the use of a sphere gap enables the results of a certain kilo-volt-peak on one machine to be duplicated on another. To calibrate each machine and tube by employing the sphere gap will materially aid in a better quality of radiographic work. It is essential to know that X-rays may be duplicated in retakes or comparative sets.

A device such as the sphere gap is connected in the circuit as near the tube as possible. When ready to test it, engage the X-ray switch with the spheres—far enough apart to increase the current resistance to that point which will allow the circuit to pass through the tube. Then operate the spheres by pulling a cord. This moves them slowly toward each other until the resistance becomes greater in the tube than at the point of the two spheres, or until the current arcs from one ball to the other. At that instant read the kilo-volt-peak calibration sphere gap. One should make two or three attempts in making the test, to be accurate.

To chart each step of the auto-control in this manner, will lead to a certain setting of both auto- and filament-controls for a given amount of kilo-volt-peak at a certain milliamperage.

Machines are all calibrated and tested at the factory, and should operate with efficiency after installation.



Kilovolt Peak (Needle Gap)
To
Inches (Spark Gap)
Inches
Kilovolt Peak
Voltage
10.03 150
9.48 140
8.65 130
7.81 120
6.96 110
6.10 100
5.23 90
4.36 80
3.47 70
2.68 60
2.05 50
1.76
1.50 40
1.27
1.06 30
.87
.69 20
.51
.33 10
.17
0
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000

Figure No. 12

CHAPTER 9

Bucky Diaphragm

A peculiarity of the penetrating power of the X-rays is that when they strike and when they pass through the body they cause a secondary radiation which fogs films. Ever since the presence of such rays has been known, a definite aim has been to eliminate them, as much as possible.

So to Doctors Potter of Chicago and Bucky of Germany belong the credit of materially increasing the analytical and diagnostic quality and value of the X-ray work—by eliminating a greater amount of secondary fog through the development of the bucky diaphragm.

The bucky diaphragm is made in various sizes and its purpose is to eliminate the secondary radiation which causes fog to appear on the developed film. This fog is, perhaps, the greatest menace to contend with when making an X-ray exposure. When the bucky diaphragm is properly constructed, it should prevent 70 to 80 per cent of the secondary rays reaching the film. By eliminating these rays the percentage of contrast and detail is amazingly increased. There may be some disadvantages in using the bucky diaphragm, such as a slight loss of detail because the object is not directly in contact with the film. Using the bucky diaphragm requires slightly more exposure time, and faint grid lines may occasionally appear on the film. But the advantages of eliminating such a high percent-

age of secondary radiation by far outweighs the disadvantages. The bucky diaphragm is especially used for spines, skulls, gall bladders, and some gastro-intestinal tracts, etc. It is rarely used in making X-rays of the chest, heart or lung, or in regional radiographs, such as wrists, hands, elbows, arms, knees, feet, or ankles.

The principal working part of the bucky diaphragm is the movable grid. Its efficiency is determined by the height of the lead strips, their thickness, and the thickness of the wood strips between each lead strip. Each bucky is tested at a given tube distance. This grid is controlled by tension springs and an oil or air cylinder which allows it to travel from side to side synchronized with the exposure time. That is to say, the grid must be in motion at the beginning of the exposure and in motion at the end of the exposure. In other words, if the actual exposure time was 10 seconds, the approximate running time of the grid traveling from side to side would be approximately 14 seconds. If this grid should stop its motion during the exposure, there would be white lines developed on the film indicating the lead strips of this grid. These, naturally, interfere when analyzing or listing the films. Then, too, if the grid should stop there would not be a great deal of reduction in secondary radiation.

There are two types of bucky diaphragms on the market today—the curved one which has a curved grid, constructed with a radius of approximately 25 inches, a flat bucky with a flat grid. The flat bucky is more generally accepted as the most satisfactory type, although there are many curved bucky diaphragms used today. The flat bucky is somewhat thinner in construction than the curved one. This allows the patient to be in closer proximity to the film, and so eliminates some distortion, and thus increases detail. The bucky with its grid operates between the patient and the film.

Stationary Grid—a later development of a grid was made by Lysholm of Sweden, utilizing the immovable form. This new grid does not replace the Potter bucky diphragm,

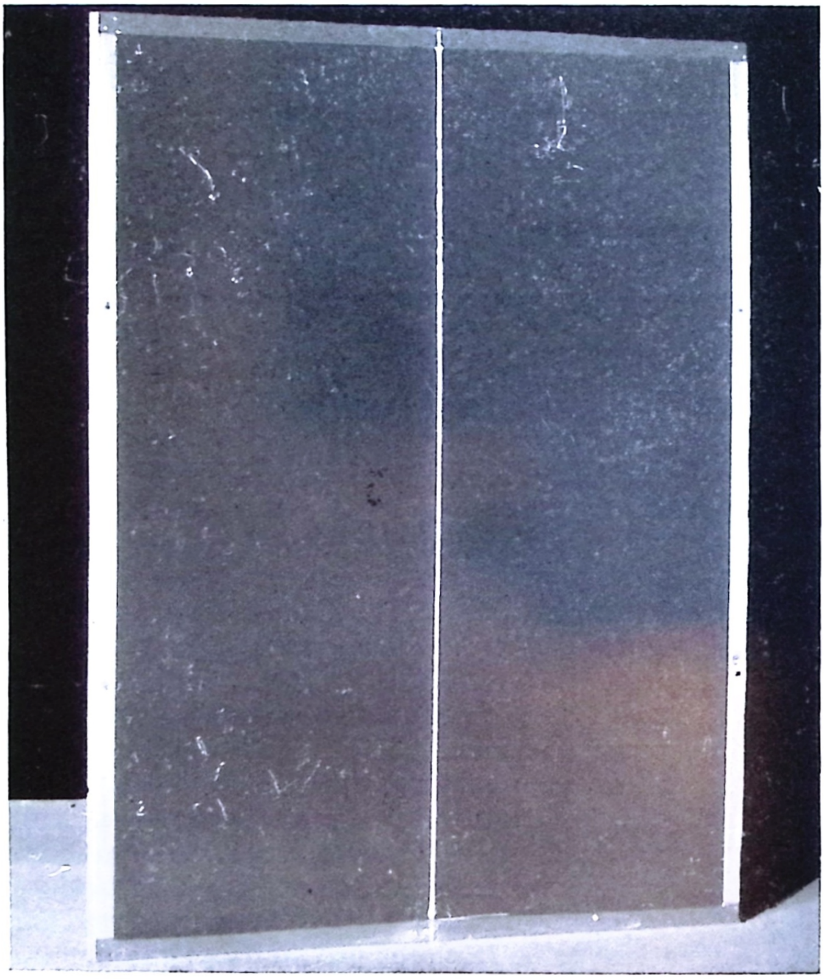


Figure No. 13
Stationary Grid

but it is an excellent supplement, offering new possibilities in the field of diagnosis. This grid is small and easy to operate, and is operated the same as the bucky grid, between the film and the patient. This new type of grid reveals very fine faint grid line marks on the film, but usually such lines do not interfere when making an analysis or diagnosis of the case from the film. This type of grid may be purchased from any X-ray accessory establishment.

The quality of spinographs or radiographs, particularly in the heavier parts of the body, may be increased by using radiographic cones or cylinders in connection with the bucky diaphragm or stationary grid. These cylinders and cones are made of highly polished metal, or of lead glass. When made of metal they are lined with lead. If made of glass, there is sufficient lead in the glass to equal 1/16 inch of lead.

The value of these accessory pieces of apparatus is far greater than many technicians realize. The purpose of such cones and cylinders is to limit the amount of tube radiation itself, thereby reducing the angling radiation to the patient and the secondary rays to the film. This results, as the experienced spinographer knows, in an improvement in spinographic or radiographic quality, for it is obvious that the more secondary radiation eliminated, the better the radiographic quality.

What actually happens when using cones or cylinders is simply this: the area irradiated by the primary beam, or path, is limited to a smaller size; so if the quantity of angling and secondary radiation given off is, in a sense, proportional to the port of entry of these rays, the amount of secondary radiation available to fog the film is materially reduced. It must be understood that certain sized apertures of cones or cylinders at its out-port, as well as in-port, must be used to cover a certain area at a given tube distance.

Spinographically, this is particularly true in making tube shifts in stereoscopic work. Such a cone should be approxi-

WARNING

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It is dangerous to operate X-ray equipment when certain established factors are not **strictly** observed. Adequate precaution must be exercised at all times to prevent electrical shock and injury from X-radiation.

mately 2 inches at its in-port when placed approximately $4\frac{1}{2}$ inches from the tube target, and approximately $6\frac{1}{4}$ inches at its out-port. Its length should be about 12 inches. A longer cone of this type would operate very inconveniently, even though it would, perhaps, increase radiographic results at stereo tube distance.

When using cones in connection with the bucky diaphragm, one must slightly increase either the exposure time or current. Better results are obtained by increasing the current, keeping the time down, and making the actual exposure instantaneous. The latter method will greatly help to overcome motion.

Double intensifying screens and the bucky diaphragm, together with lead cones, eliminate secondary rays and increase contrast and detail on the film. Therefore, proper and modern equipment, employing the use of the double intensifying screen technique, bucky diaphragm, and accessories, will increase results manifold.

CHAPTER 10

X-Radiation and Its Limits

The amount of X-radiation an individual can stand has never been exactly determined. Although much is being said by the National Research Committee about roentgens, yet up to now they have not compared roentgens with milliampere seconds. It is said the blond is more susceptible than the brunette. This is, of course, true of sun burn. However, a limit has been established to not exceed 1200 milliampere seconds for the body, and 30 per cent less for the head at any one time. It is debatable how long one should wait for further radiographs, should they be necessary. However, when X-raying a new patient, it is wise to inquire about recent X-rays, if any, to determine the approximate amount of M.A.S. used. From that a suitable technique, so to speak, can be figured. If these limits have been reached in one or two visits only a few days apart, it would be wise to wait about 10 days before making more exposures. Too much radiation could affect the heart, nervous system, blood cells, cause one's hair to fall out, affect the skin, and even cause an X-ray burn. These things may bring legal action.

Secondary rays are harmful to the operator. Soft rays are the longer wave lengths, and are injurious to the patient. Soft rays have little penetrative value. Their type of radiation is increased by using a small amount of current, a small amount of kilovolt, and more exposure time. True,

this sort of technique produces a soft, mellow picture, but it is dangerous to the patient. Incidentally, a filter should always be used to protect the patient.

A piece of aluminum approximately 6 x 6 x 1/16 inch thick, placed just beneath the X-ray tube in the tube housing, will filter out many of the soft rays. However, there may still be enough soft rays penetrating the filter to be detrimental to the patient if proper technique is not used.

Hard rays, the longer ones, are produced when using the hard tube technique using more kilo-volt-peak, or penetration, with more milliamperage and less time. This type of technique is used in spine work. The contrast and detail in the film may not be as distinct as that produced with the soft tube technique, but the danger of burning the patient seems to be eliminated by doing the work instantaneously. The more K.V.P. and current (M.A.), the shorter the wave length, and the faster the exposure can be made.

Secondary rays travel in all directions, and are produced when X-rays meet with resistance other than lead, etc. Lead, being opaque to the rays, naturally absorbs them. The speed and penetrative power of the secondary rays depends on the amount of force or voltage used in the production of X-rays. Secondary rays not only fog films, but are very detrimental to the health of the operator. He should protect himself when in constant exposure to these rays by working in a lead lined booth. Those making fluoroscopic examinations, wear lead rubber gloves, lead glass goggles and a lead rubber apron to protect himself from secondary, direct and stray radiation. Units on the market today are equipped with a lead glass bowl which envelopes the X-ray tube. And with shields, and with the tube oil immersed to eliminate stray radiation.

Secondary radiation is not only a menace to the X-ray operator, but is very injurious. It is important that the technician learn all he can concerning such rays. The National Bureau of Standards can furnish additional information on the subject.

CHAPTER 11

Qualifications for a Spinographer

Individuals who desire to become spinographic technicians should not only have some knowledge of electricity and photography, but should also know the structure of the human body. They may be either male or female. Their physical condition is a very important factor, as X-ray work may or may not be detrimental to one's health if all proper precautions are not considered. And even then it takes a very strong constitution to withstand daily consecutive exposures.

Perhaps one of the greatest essentials in any line of endeavor is character. Will-power and self-control play an important part. So for the individual with a good character, health, and a willingness to work, there is always a bright future.

The X-ray technician must inspire confidence and have an unlimited amount of patience. For kindness, courtesy and diplomacy must be used at all times in the presence of patients. Such qualities are always expected of our profession, and since the patient may want similar work done in the future, the actions of the technician may contribute much to the success of future X-ray examinations (or analyses).

What Constitutes a Good Spinograph?

There are various opinions as to what constitutes a high

quality radiograph. But there should be no difference of opinion in regard to the part which distortion, detail, and density play in getting clear-cut flats or natural stereoscopic spinographs.

Some operators prefer dark films which could only be analyzed before a very high-powered light. Others prefer lighter films.

At no time should one attempt to read an X-ray film by holding it up to an ordinary room light, or even sunlight. Illuminators with rheostat lighting are specially constructed for this work.

A dark negative will not reveal certain definite points or parts necessary in spinal reading. Certain lines of demarcation are eliminated by dark films. No doubt, there are other difficulties in respect to dark films.

As an experienced analyst, the writer's opinion of an acceptable flat or stereo-spinographic film includes a combination of the following factors: a minimum amount of distortion, correct placement, proper density, sufficient amount of detail, and contrast with clear cut outlines. In other words, he prefers a rather light film having a dark gray background, with outlines white and clean cut. This type of film offers more definite information and so makes possible better results.

Distortion—when referring to the directions in the misalignment, is the perversion of normal position. When applied to patients, tube alignment, and angling radiation, it means magnification, elongation, and lateral dissymmetry. The latter, particularly, makes film reading difficult, to say the least. It is often the cause for many errors made in the analysis. Distortion of this type is always present, except at a point directly below the tube's target.

When a mechanic reads a blueprint he first gets a mental picture of the finished product before he can successfully continue with his work. And like the mechanic, the chiropractor must know and see the normal through the abnormal before he can read a spinograph with a maximum degree of accuracy.

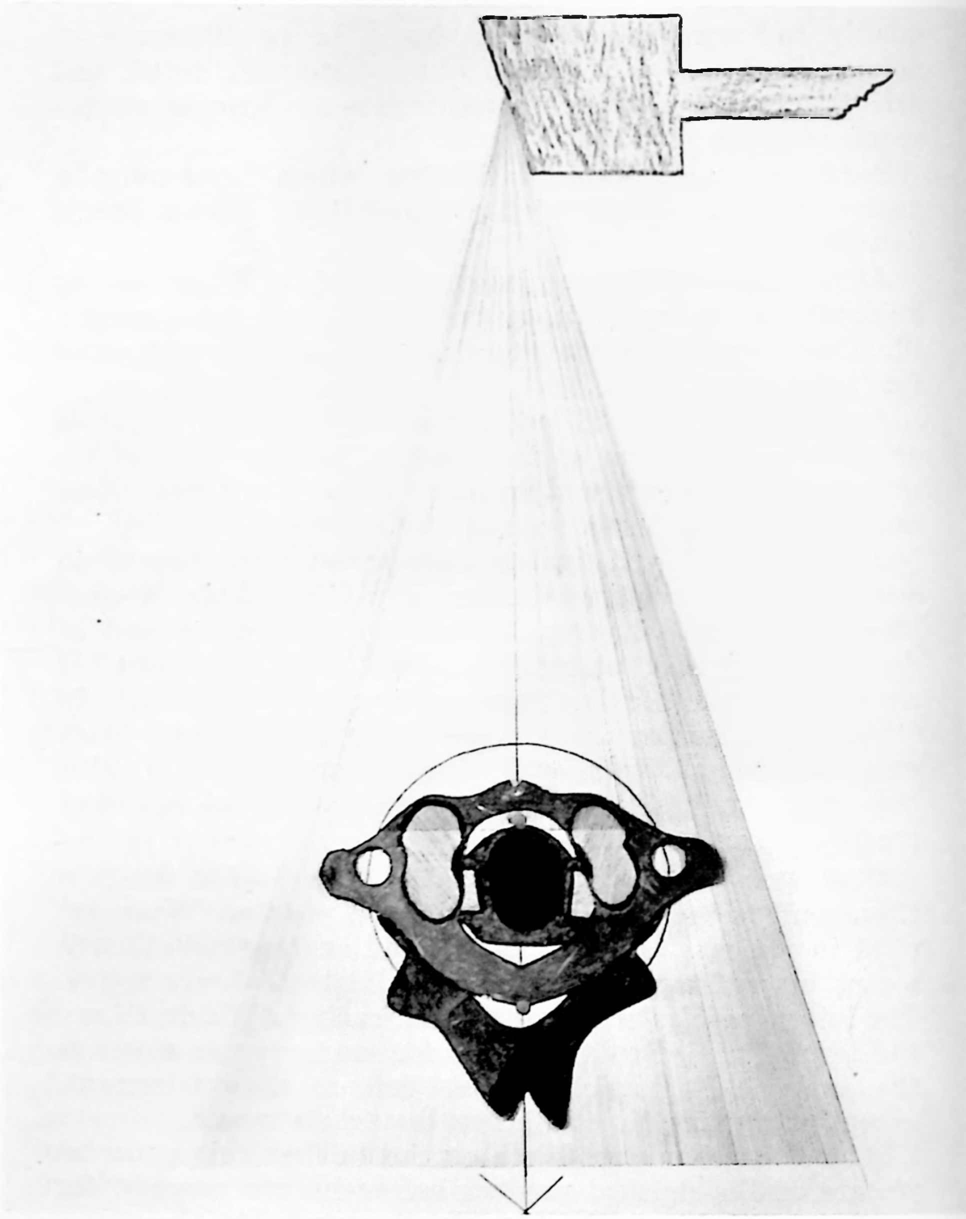


Figure No. 14
Level and centered atlas and axis relative to ray angulation.

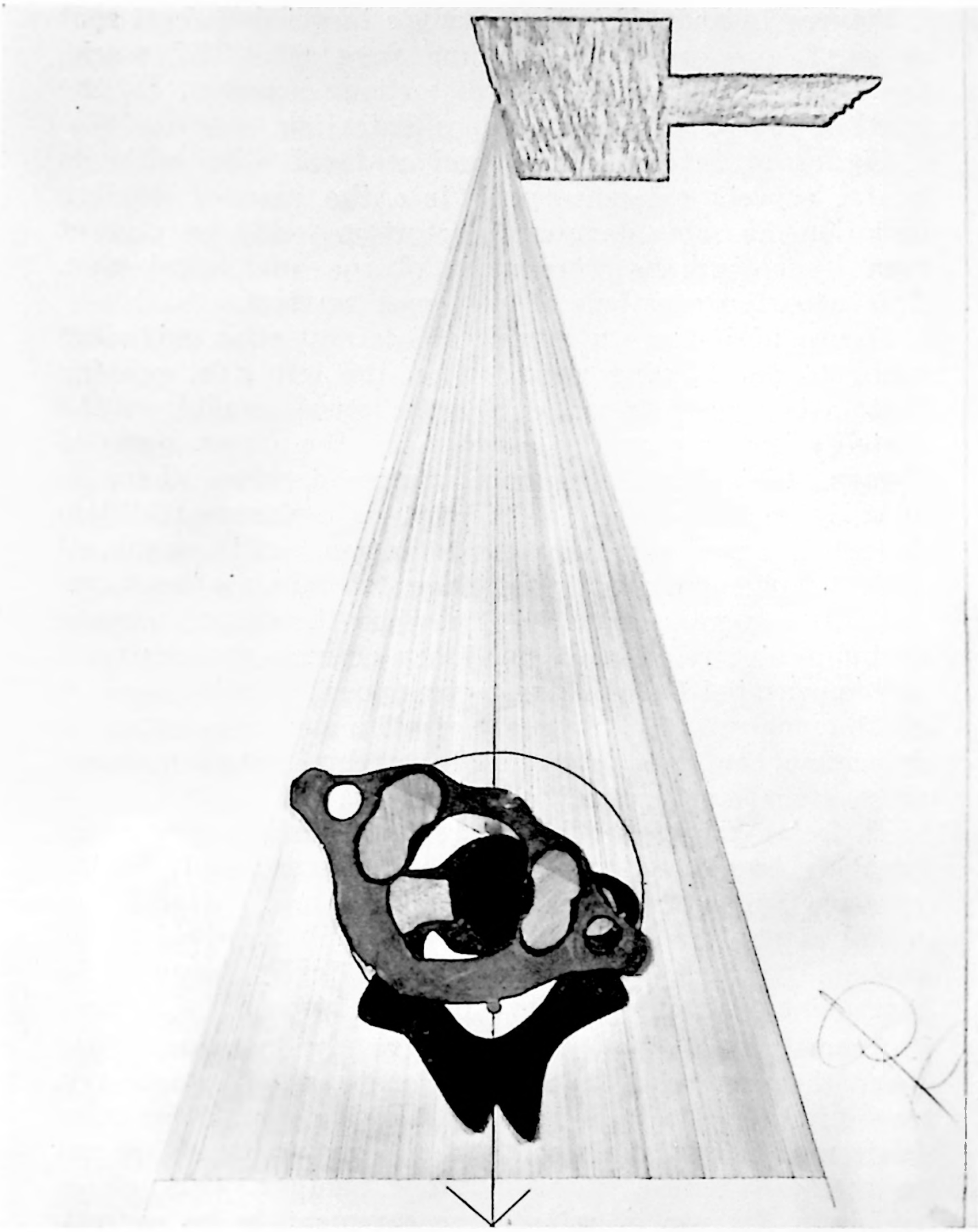


Figure No. 15
Rotated and lateral atlas relative to ray angulation.

Figures 14 and 15 show the tube's target and focal spot or point, the direct and angling rays. The "X" marks the spot where there is no distortion; however, as the angle of X-rays increases so does distortion.

Figure 14 reveals a level and centered atlas with its lateral aspects extending well into the area of angling radiation. So some degree of distortion would be present even if spinographs were made of the anatomical plan. This is particularly true of the upper cervical.

Figure 15 displays a rotated and lateral atlas extending well into the angling radiation on the left side, proving that distortion is increased by the misalignment as the vertebra moves laterally away from the direct path of X-rays. Distortion is further increased when there is anomaly and malposition of the patient in placement. When distortion results in only magnification, so to speak, it doesn't particularly interfere when determining the directions in the misalignment. But when distortion changes contours, etc., retakes are necessary or such changes must be compensated for as accurately as possible in the making of the analysis. So, degree or millimeter measuring to determine the exact amount of vertebral rotation, laterality, etc., is not scientifically correct.

To locate foreign bodies, distortion must be eliminated or their true position could not be ascertained by the surgeon. Any attempt to analyze the upper extremity of a full spine (8 x 36 or 14 x 36 inch film), would in all probability cause the reader some difficulty because the placement for upper cervical and full spine are different.

Anomaly and Mal-formation—are synonymous. They mean the vertebra is non-proportionate, not in symmetry, or did not develop according to the divine plan. Descriptive parts may not be the same size and shape; therefore not in their anatomical relation to one another. This, alone, prohibits the use of minute measurement to be correct, to say nothing about inaccuracy when malposition and distortion exist.

There is always some degree of anomaly present. No two

individuals are alike. It is not rare to notice that half of the skull is different from the other half even to the extent of being recognized throughout the face. The non-proportionate parts that are directly concerned in the analysis are the foramen magnum, condyles, lateral masses, occiput, and first and second neural rings.

The foramen magnum is often seen off center, or not in the center of the skull. It varies in size and shape. Some could be considered large—others small. They have been found to vary in width from approximately eleven-sixteenths inches to one and fifteen-sixteenths inches, and laterally from their anatomical position more than one-fourth of an inch.

Condyles vary in size, shape and pitch or angle. For instance, one condyle may be actually one-eighth of an inch lower than the other, while the angle of one may be 25 degrees; while the other may be 15 degrees, so to speak. In other words, one condyle is often found shallow.

Lateral masses are not alike. One may be actually wider or greater in depth—and to find a low occiput on one side is an everyday occurrence. This certainly proves each case is individual. Let me repeat—variables are present in every human being. However, that which is abnormal in one case may be normal in another.

Detail—when all the contour lines of the object appear, and when the lines of the hard compact structures of the bone are white, clear cut, sharp, and distinct, then the detail is said to be satisfactory. When lines are more or less hazy and indistinct, detail is not complete. The same factors that control distortion—i. e., the distance of the object from the film; the distance of the focal spot from film; the alignment of the object; the film and small focal spot; non-movement of the object, film or tube during the exposure; the film itself in perfect contact with screens; the use of the bucky diaphragm and cone—are often important in perfecting detail. However, the bucky diaphragm, intensifying screens, and faster speed film tend to distract from detail. When possible, use cardboard holders,

slower films, fine focus tube and a soft tube technique for greater detail. It must be remembered, however, that physical conditions and greater thickness of patient make it difficult and many times impossible to use all these factors and get sufficient detail.

Contrast—refers to the amount of difference between the extreme black and white over the entire exposed film area. The factors controlling contrast are voltage, time, milliamperes, fast screens, cone and bucky diaphragm. When the voltage factor is increased, there will be less contrast (if all other factors remain equal). If the voltage factor is decreased, the milliamperes, or time factor must be increased, and there will be more contrast (if all other factors remain equal). Fast screens make more contrast. Tube distance is not used to control contrast. However, when the distance is increased there is a tendency to increase contrast. With no change in the kilovolt peak, the additional tube distance lessens secondary radiation which has much to do with contrast.

The developing solution, developing time and temperature may be so arranged to produce a slight increase in contrast—but does not control it.

Density—radiographic density refers to the general density of the entire film towards a lighter or darker appearance. The degree of density cannot be fixed as a permanent quality for it is largely a matter of individual preference. Time, tube distance, milliamperes, or voltage may be used to change the density. Tube distance is rarely used because of the elements of distortion. Increasing or decreasing the milliamperes may also affect density, but this factor is not used to control it, due to the size of the smaller focal spot. Ordinarily, the factors used are time and voltage. To increase or decrease time and voltage will, respectively, increase or decrease the density. When the film is over-exposed, the developing time must be shortened to get a readable film. Experience proves that better results are obtained by arranging the machine technicali-

ties so that films may develop in efficient solution of proper temperature for five or six minutes, depending on the type of film.

Density varies directly and proportionately as to the milliamperage; directly and proportionately as to the exposure time. This means exposure time and milliamperage are interchangeable. Density varies directly and nearly in proportion to the square of the kilovoltage; and inversely as the square of tube distance.

Placement—the consideration of the proper placement of patient and tube for a satisfactory spinograph is a very important factor. It is so important that if placement is not correct, the analysis is usually incorrect.

The general detail may be very good, but if certain procedures are not carried out in placement, the film becomes of little value. This is particularly true in chiropractic work, since spinographic conclusions must be reached by comparing certain outlines of spinal segments with one another, with the patient placed in his normal relaxed position.

It is interesting to know that an improper placement of patient or tube may cause the drawing of incorrect plane lines and wedges on the film, and therefore result in an erroneous listing. No doubt this is the direct cause of many border-line failures.

Malposition—is usually present, and is the one thing which causes the greatest difficulty in spinograph reading. The analysis then becomes a real problem. Spinographs not made correctly are not read correctly. Although some degree of malposition may be compensated for, retakes are usually necessary. When minute measurement of a malpositioned patient is made of the directions in a misalignment, such procedures can be entirely incorrect to say nothing of the variables.

A good example of this is the listing of the lower cervical on the regular atlas-axis film. In atlas-axis work, the patient is placed by manually rotating his body until condyles

are parallel with the film surface, or as near as is humanly possible to do. The reason, of course, is because atlas is listed in relation to condyles. This, naturally, increases or produces lower cervical rotation, or possibly curvature on the film, when actually such conditions may not exist. So it is not wise to attempt to list the lower cervicals on an atlas-axis film, or attempt to make an atlas-axis listing from a full spine film. Placement for the two sections are entirely different. Malposition is a most important matter to spinograph readers, for the wrong listing could be a serious and vital matter to the patient, and to the adjuster, as well.

X-ray Exposure—Initial considerations in technique are unit capacity, size of the tube's focal spot, the type of intensifying screens and films to be used; then the patient's age, weight, occupation, tissue thickness and his physical condition. X-rays are not foolproof. So the procedures, particularly in spinographic work, must be exact. Otherwise, the film may reveal something that does not actually exist.

Medics look for shadows within shadows. One might say the exact spot is immaterial. However, the exposure technique must produce a type of film in which one shadow may be distinguished from another. For chiropractic purposes the spinograph must be properly made to be correctly read. Descriptive parts are compared with one another for size and density. Also, the alignment of the vertebral articulations are compared with the one above and below. So precision in spinographic procedures is vitally necessary.

At this point it should be explained that black shadows on the negative indicate little or no resistance to the X-rays. Pus appears as medium light to dark gray, depending upon the amount and the consistency. White shadows indicate resistance plus. A fracture has irregular edges and is always dark because the space or separation between the broken parts does not offer the resistance to the rays offered by adjacent structures. The shadow indicating a healed frac-

ture varies from a rather dark to medium light gray, depending on the amount of time which has taken place in the process of healing. Eventually the weld becomes light, but seldom ever white.

Unit capacity refers to current and penetration; focal spot to definition. Screens and films indicate speed and contrast. There is a minute amount of detail lost in using the bucky diaphragm and intensifying screens. However, the additional amount of speed is necessary to eliminate a percentage of secondary fog, which actually adds to both contrast and definition.

To know the patient's age indicates resistance to the X-rays, for the aged require less penetration and, possibly, less exposure time. Spinographs of elderly people are usually found to be muddy dark, with no contrast. To improve the quality, decrease the K.V.P.—seldom the exposure time.

Weight and thickness also have to do with resistance. It usually takes more penetration and, possibly, more exposure time to spinograph a short heavy individual than a tall thin person of the same weight. By the same token, more time and penetration are required to expose full spine upright than in a supine position. Upright, the viscera drops; while supine, it shifts laterally, offering less resistance over the object.

Occupation refers to muscular development. A construction worker offers more resistance to X-rays than does the man who sits at a desk all day. Physical condition is another factor to be considered, because where there is fluid the area is more difficult to penetrate. This is when case history is important.

Most any exposure chart is valuable, though it may not produce desirable pictures. At least it is something with which to start. Then add or subtract certain factors as the processing finds it necessary. This means each case is individual. But there should be no variation in the amount of time in developing.

Case history, instrument reading and then the spinograph

exposures is proper procedure when accepting a new chiropractic patient.

Methods of analysis—there is a difference of opinion in the procedures when listing vertebrae—particularly the upper cervical and lower back. Many ideas and methods are taught. Generally speaking, the profession seems to see eye to eye when analyzing the rest of the cervicals, dorsals and lumbar vertebrae. However, it is presumed it makes little difference which method is used, so long as the listings are correct and obtained in a reasonable amount of time. Time is an important factor in the chiropractic office.

Opinion is that the atlas-axis comparison is the best way to analyze the upper cervicals. The lateral, AP regular and base posterior views make the ideal set. In a very high percentage of cases this set not only determines the complete listing but provides proof thereof. However, should there ever be any doubt, a nasium or stereo views should be taken. This idea of atlas-axis comparison is very simple to apply and little time is required to make the complete listing. As a matter of fact, this method works much faster than any other in upper cervical work.

The spinograph is first examined for correct placement, then anomalies—or vice versa. Proper lines are then drawn on all films. Axis is read first because it is the basis for upper cervical analysis. Its body is compared with the median line and its spinous in relation to its body, AP view. Next the atlas is examined on the BP for rotation and its relation to axis. Then compare the distance of atlas, right or left of axis (BP view), with the distance of axis, right or left of the median line (AP regular view). Now, subtracting one distance from the other determines atlas condyle laterality.

Procedures in adjusting—there are various ideas on how atlas and axis should be adjusted—and this applies to the lower back as well. Although Innate actually makes the adjustment, the person applying the external force should

always consider the mechanics in adjusting the vertebrae.

Most important to remember in adjusting the atlas is that when it went out of position it first twisted or rotated. Therefore, to correct the misalignment, the segment must travel back along the path it went out. This means that proper contact, line of drive in accordance with the condyles and torque must be a part of the force applied.

CHAPTER 12

The Chiropractic Stereoscope

The stereoscope, as applied to spinographic work, is an instrument so constructed that the spinographer may obtain a depth perspective of the region he chooses to analyze. In other words, the third dimension may be optically realized. Heretofore, stereoscopic work has been confined mainly to such areas as the chest, pelvis, hips and skull. Through chiropractic research we are able to stereoscope the spine, particularly the upper cervical region, with amazing results.

Construction—the construction of our stereoscope consists of two 8 x 10 illuminating boxes, facing one another, each having a 100-watt blue bulb and an opal blue glass. These boxes slide on two parallel nickel rods suspended by two end-brackets. At a central point between these two end-brackets is placed a pair of mirrors with an angular and tilting adjustment for the accommodation of the spinographer's, or chiropractor's eyes. This is referred to as the center assembly. The reflection in the mirrors of the two images on the films, with the proper procedure, brings out an optical effect whereby the eyes view the spinographs as one image with depth.

There are times that the use of the stereoscope in the practice of chiropractic is necessary to render the best possible chiropractic service in getting sick people well. The importance and value of the X-ray to the profession,

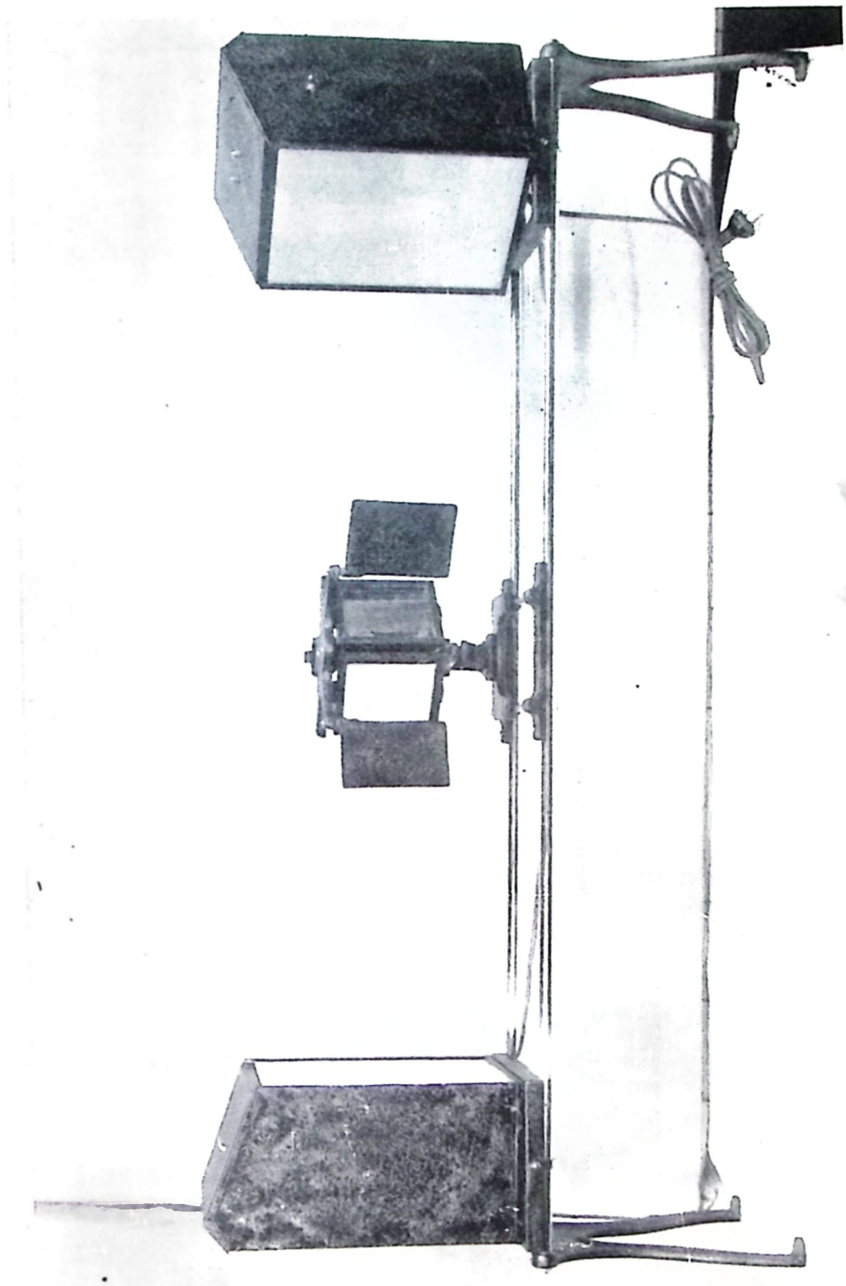


Figure No. 16—Stereoscope (8 x 10) for Chiropractic Purposes

from an analytical standpoint, has been constantly increasing since the discovery of X-rays by William Konrad Roentgen of Wurzburg, Germany, on December 28, 1895. Those who are engaged in this work realize its great importance, and that it will continue as time goes on.

Medics insist on the X-ray, many times demanding the stereoscopic work. Although dentists seldom use the stereoscope, they rely on the X-ray to locate defective and abscessed teeth. Medics and dentists who think the X-ray a fad or unnecessary are considered out of date. The time has come when the chiropractor is judged in the same manner.

Medically speaking, X-rays present about one-fourth of the procedure in making the diagnosis. Case history, physical and clinical examinations and X-rays complete the process. A similar procedure is followed in chiropractic—case history, instrument reading (to know when interference exists) and X-rays. Some cases require physical and clinical tests.

When a chiropractor insists on spinographs of every case he is looked upon as being more thorough in his practice. It is a physical impossibility to consistently palpate correctly. And it is wrong to attempt to adjust when vertebral interference does not exist. This is what defeats the chiropractor's objective.

Chiropractors can improve their service by using the stereoscope when additional X-ray information is necessary not only relative to the directions in the misalignment of the vertebral segments but to see fractures, dissymmetry, dislocations, pathology, etc.; also by keeping records on each case. I might repeat: it behooves him to X-ray at the completion of his service as well as at the beginning—and perhaps during this service. Seeing is believing. And X-rays, properly made, never fail to reveal what there is to see. Precision spinographs with the correct analyses and the knowledge of when interference exists are the greatest aids to the profession.

Each chiropractor should have a modern X-ray machine

with necessary equipment in his office. It will give him more confidence in himself. Too, it promotes efficiency for a practitioner to have access to such equipment at all times, instead of having to refer patients to some spinographer or practitioner less competent along these lines. This equipment in your office always has a decided psychological effect on your patient. Especially is this true when consulting prospective cases.

Because of inability to correctly palpate the axis in all its ramifications or the atlas with its anterior-superior, or the anterior-inferior anterior arch or possibly atlas rotation, it becomes necessary to spinograph. A lateral, an anterior to posterior, base posterior or vertex views are usually needed to decide the true position of the atlas and axis with one another and their relation to the occiput. Bent spinous processes, exostotic growths, ankylosed conditions, long and malformed transverse processes, vertebral pivots and curvatures all make it difficult to palpate the spine correctly.

Years ago we experimented with, and talked of, the advisability of spinographing in the upright position. But not until the atlas-axis specific became a working practice did we actually realize the full importance of the upright, normal relaxed posture. Much experimentation was carried on. Finally the conclusion was reached that the patient sitting up could, and did, assume a more normal, relaxed posture for cervical spinograph exposures. Although the difference in the vertebral position, either in the prone, supine, standing or sitting postures, seldom revealed the opposite misalignment on the film, it often changed the occiput from a high to low or vice versa, as well as degree of vertebral position in rotations, curvatures, etc.

Proper working equipment and correct technical procedures always make more information available, thus making the work more valuable to all.

THE FLUOROSCOPE AND ITS PURPOSE

The standard fluoroscope is an instrument used for mak-

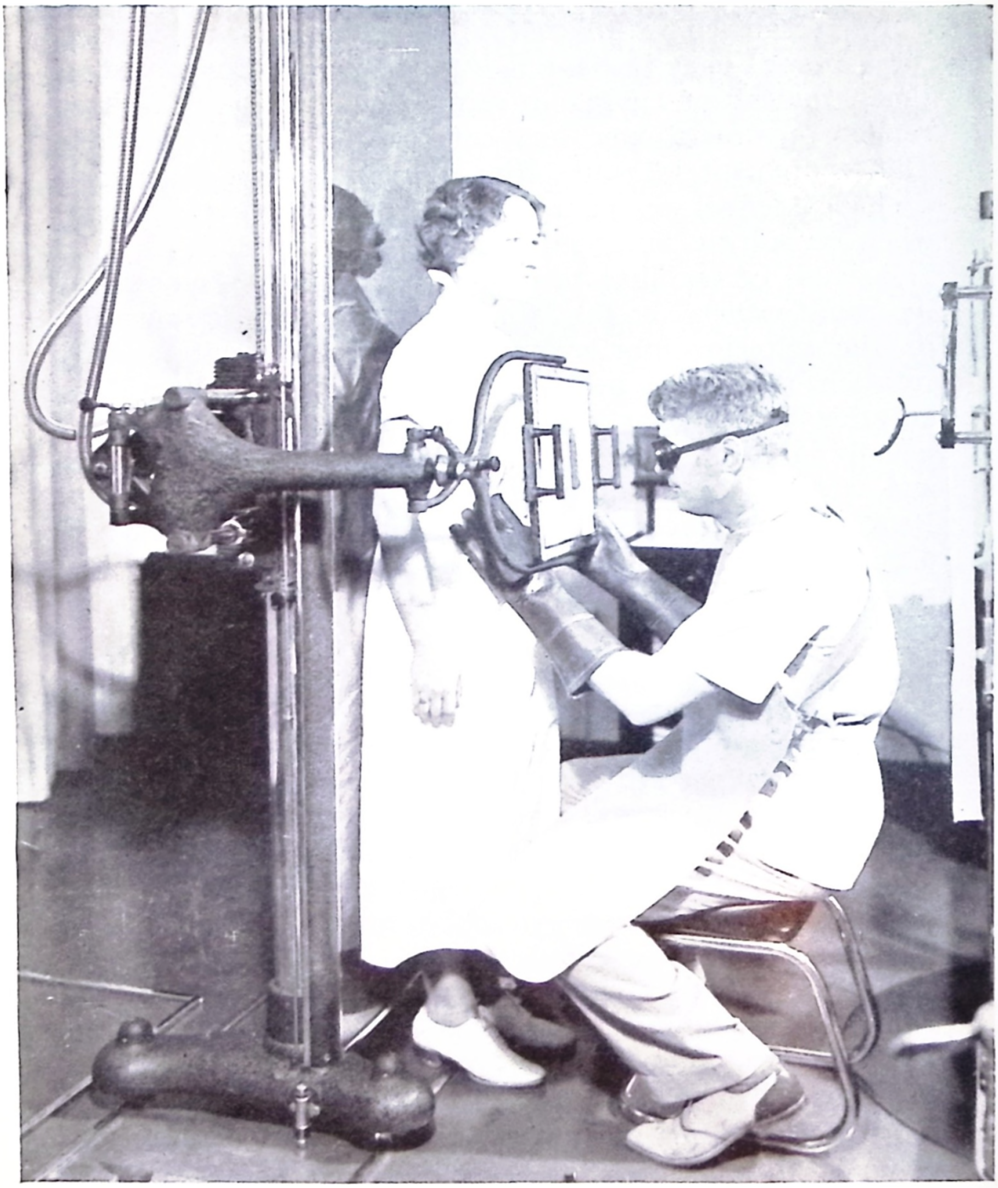


Figure No. 17
Fluoroscopic Examination

ing fluoroscopic, or visual, X-ray examinations of the patient. It is commonly used for examining chest, gastro-intestinal tracts, fractures, and for locating foreign bodies. The best results are obtained when operating this equipment in a dark room. However, the hand fluoroscope, which snugly fits the operator's eyes, may be operated in a light room. This type is used when reducing fractures or attempting to locate foreign bodies, etc.

Either the standard or hand fluoroscope may be used, with the patient upright, standing, sitting, or lying—prone or supine.

The fluoroscope is of no value to the chiropractor in determining a misalignment or subluxation—and the opinion is he should not attempt to use it.

Construction—the standard fluoroscope consists of a framework approximately three and one-half feet wide by six and one-half feet high, supporting a tube enclosed in a light-proof lead glass bowl. The fluoroscopic screen is mounted in a frame covered with lead glass, all of which may be moved up and down or crosswise to the patient. Between the tube and the patient is placed a partition of wood, bakelite, or aluminum fastened to the frame work. Also, there are lead shutters, which may be opened or closed at the will of the operator. The lead glass covering the screen eliminates most of the secondary radiation, protecting the operator's head, chest, and shoulders. But to get complete protection against secondary and primary radiation, the operator should provide himself with lead-lined rubber gloves, lead-lined rubber apron and lead glass goggles. He should also be sure that the fluoroscope is grounded to eliminate any possible static electricity. (Figure No. 17 opposite page.)

The patient is protected with shockproof equipment by the elimination of any static, and by using the proper technique in the examination. Again, X-ray exposures must be considered before making a fluoroscopic examination.

Intensifying screens cannot be successfully used for fluoroscopic purposes because they become too laggy and

grainy, and deteriorate too rapidly. The fluoroscopic screen deteriorates very slowly with use or from age.

The shutters used between the tube and the partition enable the operator to increase or decrease the size of the fluoroscope field. The smaller the field, the sharper the object and the finer detail obtained. Almost any type of Coolidge or Eureka focal or lined tube will operate within the fluoroscope, but in the writer's opinion, a fine focus tube is better for fluoroscopic use. This type produces sharpness and very fine detail, which are of vital importance when making such examinations. From 5 to 10 milliamperes is ordinarily used in fluoroscopic examinations, with from 50 to 70 K.V.P.

Fluoroscopic Room: Protection—the standard fluoroscope should be operated in a dark room, since ordinary light interferes with the visibility of the fluoroscopic image. Either red or green lights may be used for the required general illumination of the room, although a totally dark room produces the best results. The operator should remain in the darkened room before the fluoroscopic examination to allow the pupils of his eyes to fully dilate. Intermittent exposures aid greatly when increasing the life of the tube, and are less dangerous to the patient.

Milliampere second limits must also be considered in such examinations.

CHAPTER 13

Double Intensifying Screens

Since the discovery of X-ray there has been a great demand for some means of reducing the radiographic exposure time. Constant contact with the X-ray is injurious to the operator, even though he employs modern protection other than operating in a lead-lined room. Also, too many lengthy consecutive exposures may do great harm to the patient. So any possible reduction in X-ray exposure time will add to the safety of both the patient and operator. And too, it is an important factor in coping with motion. Motion on any X-ray film means the film is of no value.

To meet this demand, highly sensitive films were made. But they, too, have received their share of criticism because those using the films failed to realize that the more sensitive the X-ray film became—the more sensitive they were to all causes of deterioration. This, however, is not true with intensifying screens, as the sensitivity of the screen's fluorescent crystals seemingly does not change a great deal with age. Therefore, it is evident that the road to a shorter exposure is through the medium of fairly fast, well-balanced, intensifying screens, rather than a faster, highly sensitive X-ray film.

The intensifying screen consists of a thick pliable or flexible base—usually white cardboard—bound and coated with a solution of minute calcium tungstate crystals which,

when excited by the X-ray, will fluoresce. When these screens are in perfect contact with the film emulsion, the screen's fluorescence intensifies the action of the X-ray.

Calcium tungstate is used in the screen emulsion because it not only gives off light of a desired quality of fluorescent rays when excited by the X-ray, but it is also a stable compound that seemingly does not deteriorate under X-ray bombardment.

Purity of the calcium tungstate is of utmost importance, as it determines the quality of this fluorescent light, which should be composed of the maximum amount of blue, violet and ultra-violet rays.

When the calcium tungstate is pure, the exposed X-ray negative will then be free of the grainy appearance characteristic of an inferior grade of crystals, or of crystals which are too large or not equally divided. The wave length of the fluorescent light is said to be much longer than that of the X-ray. Suitable material must be used to hold the calcium tungstate crystals suspended. This material is called a"binder." The quality of this binder is very important. An inferior quality may turn yellow under continuous use or age. This causes the screen to become slow in its action, and may result in an unsatisfactory film.

The analytical or diagnostic value of the X-ray film necessitates the use of the best intensifying screens available, for, X-ray films are no better than the intensifying screens that make them, with few exceptions. The fine qualities or the defects in the screen's emulsion invariably manifest themselves in the finished spinographic or radiographic film. It is not uncommon to find technicians in certain X-ray laboratories who frequently complain of a variation in the speed of the X-ray film used. Their true difficulty probably stems from a mixture of old and new, or slow and fast screens from various manufacturers. If the screens are too slow, one has to sacrifice speed of the exposure under conditions where it may often be an essen-

tial requirement. This increases the possibility of blurring due to motion, and results in wasted films.

Therefore, the use of the same type of screen—new or old, fast or slow—from the same manufacturer, is very important. Particularly so in stereoscopic work. Since motion on the spinograph or radiograph, produced in any manner, must be eliminated to properly fuse the films. Stereoscopic films must be as nearly identical as possible. There are several makes of intensifying screens made in slow, medium and high speed types. Each type has different values. For instance, there are cases for X-rays which require work which must be done instantaneously. This necessitates a rather fast type of screen. On the other hand, there are cases which require more exposure time with certain types of tubes. In these a slower screen may be used. Extra speed screens for general and all around work may be used to better advantage.

It is not ethical to discuss here which of the standard manufacturers make the better screens, for that may be largely a matter of opinion. But one should consider the manufacturer's reliability when selecting intensifying screens. It is his reputation on which you must depend in respect to a variety of physical defects which the ordinary X-ray laboratory's testing facilities will not detect until too late. The only practical method of testing screens for speed and contrast in your X-ray laboratory is by comparative exposures of heavy objects. Never attempt to compare sets of screens if one set is contained in a bakelite and the other in an aluminum front cassette. The bakelite offers less resistance to the X-rays, and so requires less exposure time.

In the construction of intensifying screens there are several features to keep in mind if the highest quality work is to be done with them. These qualifying facts are grain, lag, speed, uniformity, contact and ease of cleaning.

Always avoid screens which are grainy due to the uneven size and distribution of calcium tungstate crystals. Such

imperfections may distort—and even obliterate—the fine detail of the spinograph.

Laggy screens sometimes possess an afterglow. This results in radiographs of either a hazy nature, or those which have the appearance of double exposure. There may be white specks or minute spots appearing on the developed film. These should not be confused with laggy screens. They are usually the result of dirty screens. To test for lag, place a small piece of coiled steel wire on the top or face of the cassette—the cassette containing no film. Expose as in the maximum routine work. Immediately remove the cassette to your darkroom and insert an unexposed film. Allow the film to remain in the cassette in your darkroom for 10 or 15 minutes. Then remove the film from the cassette and follow the regular developing procedure. If an outline of the coiled wire appears on the developed film, it is positive proof of afterglow. Such intensifying screens should be discarded.

Speed refers to the relation of the amount of X-ray density required by films exposed with and without intensifying screens. For instance, a given technique will produce a certain amount of radiographic density on a film exposed without screens. But the same density, using the same technique, can be obtained on a film with intensifying screens in much less time. In other words, use of the modern double intensifying screens will reduce the time element as much as six or seven times.

Uniformity depends largely on the quality of chemicals used in the screen's emulsion, and an evenly divided fluorescence over the entire screen's surface. If screen contacts are good and the fluorescence evenly distributed, there should be no dead spots on the film.

Screen contact refers to the proximity of the screen and film surfaces. Improper contact is the result of screen mounting, or the use of an inferior grade of cassette—or both. Poor contacts will result in haziness or fuzziness on the developed film, which materially affects the film

detail. Motion of the patient or tube is often blamed when the difficulty is actually poor screen contact.

To further increase film results, keep screen surfaces clean—free from dust particles and splattering or splashing of the darkroom chemicals. Dust particles will embed themselves in the screen emulsion, and white specks on the negative will result if screens and cassettes are not brushed out daily. A soft camel hair brush is advisable for this.

Intensifying screens represent many a dollar to the commercial X-ray laboratory, so great care should be exercised in preserving the emulsion on the screen's base. Avoid finger prints; handle the screens only by their extreme edges. Do not draw or slide the film over the screen's surface. This will not only scratch and eventually deteriorate the emulsion, but it will also produce static, and the films developed will reveal fine black lines.

When a cassette is not in use, it is advisable to place it in a piece of thin white clean cardboard or tissue paper; then close its cover. This will prevent the screens from coming in contact with one another, and also will keep them free from dust and dirt.

It is not advisable to pick the film out of the cassette, for this will often peel off part of the emulsion, destroy the crystals, and start the screens on their way to destruction.

As all up-to-date screens are washable, dirt or even wet solution spots may be removed without material injury to the screen surface. A tuft of cotton, Ivory soap and a small amount of lukewarm water will remove the dirt. Wet chemical spots may be immediately removed with a tuft of cotton saturated with peroxide. But if such spots become dry, nothing will remove them without injury to the screen's emulsion.

The best results in drying screens are obtained by using a piece of cotton and then placing the screens in sunlight. The sun will not only dry, but will also tend to bleach them. Be sure the screens are perfectly dry before attempt-

ing to insert film. Tacky screens will adhere to the film emulsion. This will result in not only a poor film, but will also break up the calcium tungstate crystals and so ruin the screen.

The mounting of screens is simple, yet it must be carefully done. The two screens are mounted with pieces of adhesive; one placed on the cover and one on the bottom of the cassette—with the screen's surfaces facing one another. This procedure should be arranged so that screens will make a perfect contact with both sides of the film.

Cassettes—the cassette is a device in which two intensifying screens are fastened. It carried the film throughout the exposure, thus keeping it light proof. A cassette can be had in either aluminum or bakelite face. The latter offers less resistance to X-rays.

It consists of a frame, cover, and cover hinges. Felt lining is placed on the inside of the cover and around its edges. This makes for better contact of film and screen, and eliminates all possibility of the film becoming fogged because of ordinary light leakage. Springs, usually two, are fastened to the outside of the cover. This locks it with the frame to further insure better contact, and prolongs the life and efficiency of the screens.

The hollow steel frame is considered superior to the aluminum frame casting, for the aluminum type often cracks or loses its shape when it is accidentally dropped or gets rough usage. Also, the hollow steel frame cassette is dye-formed and produces perfect alignment. It represents strength and rigidity, and should last indefinitely.

X-RAY FILMS

There are many manufacturers making X-ray films which ordinarily present good diagnostic and contrasting negatives, for with competition as keen as it is, all film manufacturers are forced to turn out a standard quality product.

So, generally speaking, all X-ray films are good. They are made in large rolls and cut for use. The popular sizes are 8 x 10″, 14 x 17″, and 14 x 36″. The 18 x 40″ size

can be had, but at the present time is made up on special order.

For chiropractic purposes, the technician is not desirous of black and white contrast, but a clean-cut film with sharp outlines. That is to say, a film revealing more white and gray with thin white outlines, for the chiropractor compares vertebral contours. To meet other demands, shadows within shadows, or areas within areas are sought.

Negatives too dark obliterate certain definite points in which the chiropractor is most vitally interested. True, a film too light is of no value. It is the medium type that offers him the best results.

Films presenting speed, a certain amount of contrast, freedom from chemical fog, and having absolute uniformity include the outstanding points required by the chiropractor. It is said that the geographical location of a plant plays an important part in making film emulsion, as a certain kind or quality of well water must be used. If certain impurities are found in the water, the gelatinous emulsion will absorb them. This causes films to take on a muddy or smoky appearance. Therefore, the better the water supply, the better the quality of films.

In processing X-ray emulsion, certain foreign chemicals are formed in the emulsifying of the silver. If these chemicals are not entirely removed during the washing process, fog, as well as a poor keeping quality will result. Film speed is dependent, to a large extent, on the keeping quality.

The silver bromide crystals, which should be very fine, will aid in the registration of contrast and the most delicate detail. They also resist, to a considerable degree, the softening effect of warm wash water.

Film deterioration is largely the result of exposure to heat and moisture. It is not advisable to carry too great a film supply during the summer months or heated periods; and those on hand should be kept in a cool, dry place.

Film difficulty is more noticeable in faster than in slower speed films. During the past few years the speed of X-ray

films has greatly increased, and complaints due to deterioration have become more noticeable.

Often, films beyond the exposure date may be processed with some success by slightly reducing the normal exposure, and developing them in a solution a few points less than the average developing temperature of 65 to 68 degrees Fahrenheit.

Film Developing Hangers—these are an important part of one's equipment and are used more often than other dark-room accessories. Therefore, they should be substantial, practical, free from corrosion, and conveniently placed for loading.

It is not advisable to attempt to develop X-ray films in a tray omitting the hanger and using small dental clips. Such a procedure will, in all probability, cause finger prints —sometimes to the extent of losing the emulsion at that point on the film. It promotes the appearance of blisters on the finished product, and results in a very unsatisfactory, unprofessional-looking negative.

Hangers are made in long and short bar types to fit almost any developing tank on the market. The bar itself refers to the top piece which keeps the films suspended in the solutions. A special type is manufactured with attachments for 14 x 36″ and the 8 x 10″ films. Processing of these may be made at the same time.

A developing hanger consists of a bar, a frame, two springs, and four to eight clips, or more, as the need may be. The life of a developing hanger will be considerably increased if the water in the wash tank is allowed to completely submerge the hanger during the film washing process. Developing hangers should occasionally be submerged in acetic acid which will remove all corrosion.

CHAPTER 14

X-Ray Tubes

An X-ray tube can be considered the most essential part of the X-ray machine. When excited by an electrical current, it produces X-rays.

Tubes are manufactured in two general shapes. Those in greatest demand are of the rectangular shape. The other type of tube looks like a round glass bowl with glass arms, somewhat resembling test tubes, extending from the bowl in opposite directions.

Today, X-ray machines are made shockproof, with filters to absorb the stray radiation. The tube is encased and immersed in oil—therefore, the necessity for the tubular-shaped tube. The oil disperses the heat. In older types of tubes the heat was dissipated by the glass bowl, and by a radiator attached to the anode, or positive end. Without filters, the stray radiation extended out from the tube. The non-shockproof machines possessed uninsulated wires running down to the tube, which made the taking of radiographs a hazardous procedure, with dangers of electrical shock.

Excluding the right-angle dental tube, there are about a half-dozen other types available today. Only three will be discussed here because they are most important for radiographic purposes. The one most generally used is the double focus stationary type, oil immersed, with a focal line as fine as 1.5, up to a broad focus of 5 mm. Second

type is the rotating anode double focus, with small focal line of .5 mm., up to a broad of 2 mm. This tube is, without question, the best and should be used with all units having a capacity of 100 kilovolt peak and 100 milliamperes or larger. It performs better and longer, has greater capacity and can be used in therapy, as well. Eventually, the rotating anode tube may replace all other tubes. There are two reasons why more of them are not used—the cost is several times higher than the price of the other tubes, and most doctors, generally speaking, have only a small unit in their office because they take only extremities or less dense structures. Cases of broken backs, spines, skulls and, possibly, chest are referred to hospitals. Therefore, they have no need for larger equipment. Even the hand-type fluoroscopic screen can be used with the smaller machines and tubes of lesser capacity.

Figure No. 18 is the single focus 30 or 50 milliampere, radiator type, which is self-rectifying. No doubt, there will be a few of these tubes manufactured for some time to come, mainly for replacement purposes. This type is used with smaller units. The double focus stationary type, oil immersed tube has a similar appearance.

Two important factors are to be considered in the operation of any X-ray tube. First, tubes are rated according to their kilovolt and milliampere capacity and their focal and time exposure values. Rating charts are available for all types, and the operation should never exceed their rating. As a matter of fact, it is always wise to stay reasonably below their rating. Second, the procedure must preserve the tube because it is fragile, expensive, and more or less temperamental. With proper care they may last for several years. Or they could be easily ruined in a short time. The X-ray tube demands the utmost care.

The first efficient tube to be used successfully in bone work was the Coolidge tube. It was named in honor of its inventor, Dr. W. D. Coolidge, who was then in the research laboratories of General Electric at New York. It became available to the profession in 1912. Since that time many

Figure No. 18
Single focus radiator type X-ray tube.

other tubes have come into existence. Today, however, the majority of these tubes are considered obsolete; yet, some are still being used.

Hot cathode tube—is the modern type, self-rectifying up to a certain degree of heat. It was developed for fine detail, rapidity of exposure and for shorter wave lengths. It contains two metallic electrodes; a cathode, which is negative and also referred to as the filament end, and an anode, which is positive. This tube is practically gas-free. In other words, it is nearly a perfect vacuum. The cathode has a flat or cup-shaped reflector in which a small coil of filament wire is assembled. The anode is constructed of copper or molybdenum. The inner surface is cut at an angle of approximately 22 degrees. In the center of this angle, which might be called the face of the anode, is buried a block of tungsten. This is called the target. Tungsten is used because of its high melting resistance. The target and filament are directly opposite one another, approximately one inch apart. The hot cathode tube is advantageous because the electrons and high potential are easily and accurately determined by regulating the temperature of the filament. In other words, the degree of heat increases or decreases the number of electrons. So by accurately regulating the quantity and quality of current, X-rays of better radiographic results are produced.

Principle of operation—the hot cathode tube has a very high degree of vacuum. It operates by means of electrons which are emitted frcm the filament when it is heated to incandescence. When high potential is applied, a stream of electrons is forced to travel at tremendous speed towards the anode. The speed is governed by the velocity of the potential. This stream is known as the cathode stream, which is directed to the focal point on the target.

The production of X-rays—(sometimes called Roentgen rays) is accomplished by a source of electrons, a means of setting them into rapid motion, and abruptly stopping them against the target. Rays which are cast directly

downward are called X-rays or direct rays. Those that angle away from the direct path are called angling rays. From these rays most of the secondary rays develop. X-radiation also includes the long and short wave lengths, sometimes referred to as soft and hard rays, respectively. Stray rays are those which strike the anode—not the target—and extend in all directions. They are useless. In fact, they could be a menace. As stated previously, however, the modern tube absorbs them by filters.

Double focus tube—contains two filaments and has two focal spots—thereby earning its name. One spot is fine; the other, broad. Only one spot is used at a time. A switch is mounted on the cathode end to change the focus from fine to broad, or vice versa.

Gas in the tube—may appear in two ways. First, by overloading it, attempting to force more current through it than it can actually accommodate, or by too-lengthy exposures. Secondly, from a small leak in the glass tube itself. Usually the leak is found at either end of the tube where the anode and cathode assemblies are sealed. If and when the tube is gassy, a greenish fluorescence might be visible. There would be, however, a fluctuation of the milliamperes and, in all probability, the desired amount of milliamperes could not be determined.

Discolored tube—discoloration is due to chemical changes within the tube during the production of X-rays—a deposit of tungsten due to the bombardment of the cathode stream against the target also makes for discoloration. This coloration does not materially interfere with the quality of work, but it may shorten the life of the tube. Tubes should be kept free from dust and moisture, for a discharge of the high tension current might puncture the tube.

Rotating anode—is the greatest achievement in the manufacture of X-ray tubes. The characteristics differ from the conventional double focus tube in that the cathode stream does not strike continuously throughout the exposure at any one point of the focal spot. This is accomplished by

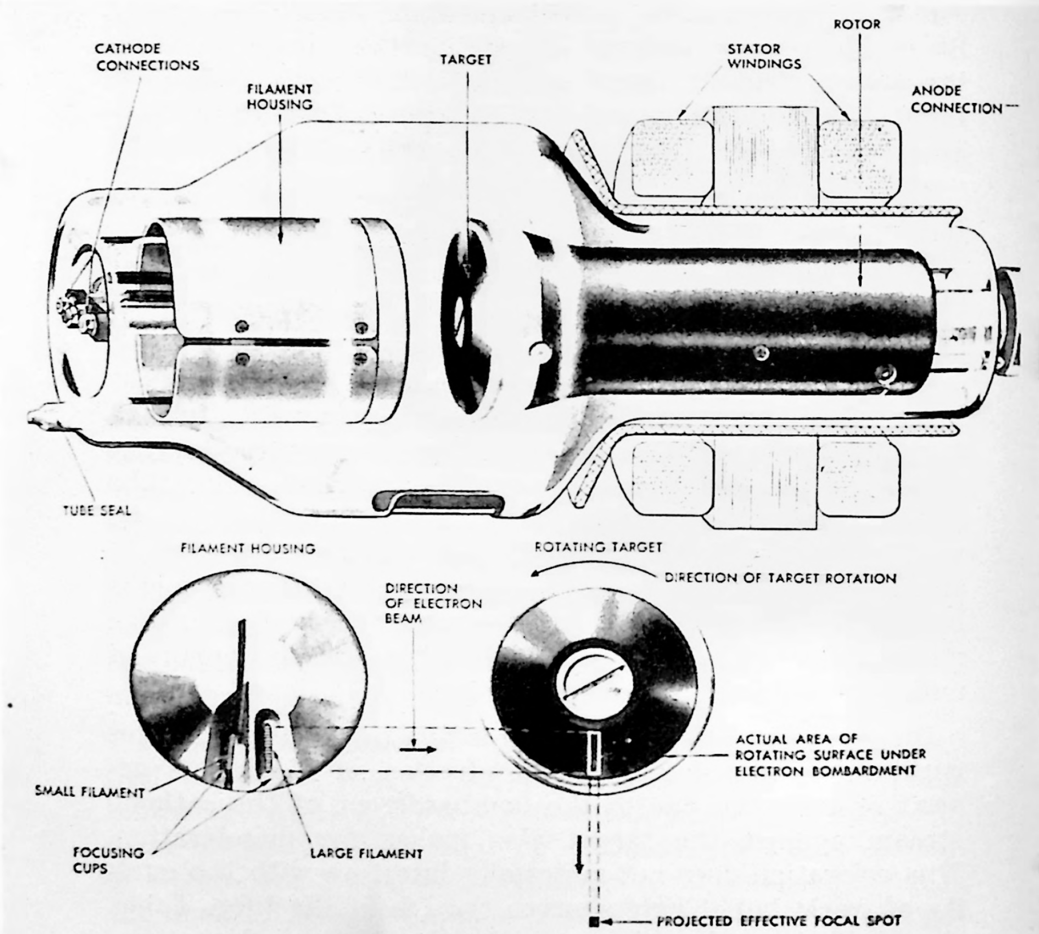


Figure No. 19
Rotating Anode Tube

rotating a large round tungsten target by an induction motor. This requires special lubrication, since the heat generated by the tube would evaporate the ordinary lubricant and produce gases to destroy the vacuum. The rotating anode permits operating the tube at much higher capacities with a smaller focal spot. However, its delicate and complicated mechanism has increased the fragility of the tube. Naturally, this type of tube costs more.

The rotating anode tube weighs much more than other tubes—including the double focus oil-immersed stationary type. Therefore, larger and heavier mountings are necessary. Usually, a ceiling and floor track is required.

Rectification—means that the alternating current, prevalent in this country, must be changed to a pulsating direct current. In other words, direct current, itself, does not have the potential necessary for radiographic purposes. The alternating has. But since the alternating current reverses its direction on every cycle, and since the current must travel into the tube in the same direction at all times, it is necessary to convert the alternating to a pulsating direct current. The contrivance used for this purpose is called a rectifier.

At the present time there are four types of rectification in use. The X-ray tube itself may act as a rectifier when the current heat is below a certain temperature. In other words, the voltage applied must keep the anode positive and the cathode negative. When the current flows through the tube in pulsations, it is called half wave rectification. Another type is the mechanical rectifier, the use of which is called full wave rectification. This requires a mica disc or a metal cross arm—each having four electrodes connected to one another in pairs; then a switch, or converter synchronized by a motor. At each alternation of the alternating current, the switch reverses. But because of the four electrodes on the rectifier, the current is always in contact with them, keeping the current flowing properly and continuously into the tube. The other two types of rectification are the two and four valve rectifiers. The two

valve is half wave, and the four valve is full wave. The advantage of four valves is that both halves of each cycle of the alternating electro-motive-force are applied in the proper direction to the X-ray tube.

The mechanical and two valve rectification are obsolete and apparently are not manufactured now. As stated previously, however, these four types of rectification are still in use at the present time.

CHAPTER 15

Exposure Factors

There is always some difference of opinion as to which type of exposure constitutes the proper spinograph or ideal radiograph, but all will agree on the necessity and importance of an X-ray film that will reveal:

- Absolute precision placement.
- Osseous or soft tissue definition.
- Analytical or diagnostic contrast.
- The least amount of distortion.
- Sufficient film density to bring out these qualities.

It must be remembered that X-rays are not fool-proof. Too many are not properly taken or correctly read, either because some part of the technique was incorrect, or improper placement was not recognized and not compensated for at the time the spinograph was analyzed. One may be able to describe a bone, an organ or spinal articulation. But to be able to recognize these parts on the film seems to be another thing. This means the chiropractor must have some sense of imagination. Before he takes up the study of commercial X-ray he must be well grounded in osteology and anatomy. When I say "well-grounded" I mean just that, for he will then have less difficulty in recognizing descriptive parts on the film.

The chiropractor has rules to follow when taking and

reading his films. But he must remember that anomalies and malformations and some degree of malposition and distortion seem to always exist to bring about an exception to the rule. This means there are no two individuals alike, and that all spinal columns are different in some respects. This is particularly true of the upper cervical region. Experience then becomes the important factor. Any X-ray course only establishes a foundation which the student may build upon through his experience. Like any apprentice he learns to measure and lay out his work. When he becomes a journeyman he should have the rudiments. Then he begins to build on his foundation. If his foundation is solid and he has mechanical ability—and if his experience continues to build—he becomes successful. This is true in any endeavor.

When these five qualities are realized it will be readily understood that they govern the quality and value of any X-ray film. Though these qualities are essential, they are entirely independent of one another and may be separately controlled and consistently duplicated, so to speak.

Technically, there are five prime factors necessary in the making of any radiograph. They are milliamperes (M.A.) and kilovolt peak (K.V.P.), which are controlled by the X-ray machine. Next is exposure time (M.A.S.) and tube distance, which are controlled by the technician or operator. The fifth is the thickness or density of the region to be exposed. To determine thickness in inches or centimeters is simple.

Exposure time or milliampere seconds (M.A.S.) is the product of M.A. x exposure time in seconds. For example:

20 M.A. x 10 sec.=200 M.A.S.
10 M.A. x 20 sec.=200 M.A.S.
50 M.A. x 4 sec.=200 M.A.S.
100 M.A. x 2 sec.=200 M.A.S.
200 M.A. x 1 sec.=200 M.A.S.

The effects of milliampere seconds on the X-ray film may be compared to the effect of light through the photographic camera. The amount of light is determined by

the size of the opening of the shutter, multiplied by the exposure time.

The opacity of various parts of the body in different individuals varies the density, even though the body thickness is the same. For instance: two persons measuring 8″ through the pelvis—which is equivalent to approximately 31½ centimeters (centimeter is 1/100th of a meter or 0.3937 inches)—do not offer the same body resistance to the X-ray because one individual exercises and develops his muscles, while the other sits at a desk. By the same token, two individuals may measure the same, one person being 30 and the other 60 years of age, but do not react the same on the film. At the age of 60 many people lose much of their calcium, which means their spinal bones offer less resistance to the X-ray. So as the body density changes, the technique must be changed. Muscular development requires a heavy technique, so to speak, and vertebrae having less calcium demand a lesser technique to produce sufficient contrast and the necessary detail. In other words, there can be no set technique or radiographic rule that will suffice satisfactorily for all individuals. Spinographic technique changes with patient's age, thickness of part, and some physical conditions, assuming all other factors are equal. Therefore, it is only the intent throughout this text to give you a good film foundation; a starting place, or the first step to take the first or trial picture. From the outcome of this you should have an idea what to do if the second exposure is necessary.

In order for one to consistently produce spinographs or radiographs of desired quality the technician or operator must possess some amount of skill along with a thorough knowledge of the fundamental principles which tend to vary X-ray technique. To meet these requirements, experience is necessary. Naturally, the more experience one has along certain lines, the better fitted he is for that particular task.

From various textbooks and equipment manufacturers it is possible to obtain complete technique charts. But at

best they can only be used as a guide; and because of existing conditions in various localities, alteration of such charts usually will have to be undertaken. Certain individual habits, preferences or procedures on the part of the technician or operator will change technique factors from what another technician may desire. Therefore, the important thing for the technician to aim at is desired quality of films by becoming familiar with his equipment, striving to apply the fundamental laws, and observing with a critical eye his results with the thought of constantly trying to improve his work.

An X-ray film of desired quality should possess a proper ratio between fine detail or definition, sufficient density, and ample contrast with a minimum of distortion. The density of any radiograph will depend largely on the amount of radiation reaching the film. The intensity of radiation varies inversely as the square of the focal film distance. Generally speaking, it requires approximately 33 kilovolt peak to penetrate one centimeter of tissue thickness. For every additional centimeter of tissue thickness it then becomes necessary to increase the voltage by approximately 2 kilovolt peak. Another general rule is to double the thickness of part in centimeters and add 25 to 31 which, in most instances, will give one the proper kilovolt peak.

To make a film with a minimum amount of distortion, the tube distance should be increased so that the wider angle of angling rays miss the film entirely. But to do this the time exposure factor or the amount of current (MA) must be increased. When operating equipment with a comparatively small milliamperage capacity, it becomes necessary to increase the exposure time, within reason of course, over the manufacturer's rating of that particular tube being utilized. When tube distance is doubled, radiographic intensity is reduced to over one-fourth. Therefore, four times as many milliampere seconds will be required to produce the same effect.

The relationship between milliamperage and time is often

a variable factor. When spinographing children, mental cases, or persons with uncontrollable muscular incoordination, it is advisable, in order to eliminate motion on the film, to increase the milliamperage and decrease the time. Milliamperage and time go hand in hand, because the intensity of radiation is essentially the product of time. Generally, when the milliamperage is increased, the time factor is decreased and vice versa. Suppose, for example, the desired technique called for 200 milliampere seconds. The capacity of the tube, being only 50 milliamperes, would permit the operation of that tube for four seconds. Its operation for one second would produce 50 milliampere seconds; and 25 if operated only one-half second.

While there is no proper relationship between kilovolt peak and time, still it is possible to compensate for the correct amount of film density. If one is desirous of decreasing exposure time, say 40 per cent, using double intensifying screens, he should increase the kilovolt peak approximately 10 per cent. A further application of this general rule is that to decrease 10 kilovolt peak, nearly twice the milliampere seconds is required; while a decrease of 15 kilovolt will require about four times the milliampere seconds.

Keeping in mind the above laws which underlie technique factors, it is then possible for one to establish exposure factors to be employed in his own laboratory. Since we already know that approximately 33 kilovolt peak is necessary to penetrate one centimeter of tissue thickness, and an increase of two kilovolt peak is usually necessary for each additional centimeter of tissue thickness, it then becomes a fairly simple matter of measuring and determining the approximate amount of penetration. With tube distance, bucky and screen requirements already determined, the time and milliamperage relationship, plus the type of screen and the efficiency of the developer, remain the only additional factors to determine. As a general guide, one could use the following milliampere seconds, keeping in mind there are many combinations in the milliampere sec-

onds to employ in the taking of any radiograph. What works for one individual may not work for another. What one individual desires may not satisfy another. For this reason you will find various combinations in technique throughout this text.

Cervical or Dorsal spine	75 to 150
Skull	75 to 150
Pelvis	75 to 150
Lumbar spine	150 to 200
Abdominal viscera	60 to 100
Chest (6 foot)	10 to 20
Extremities (No screens)	100

Depending largely upon the tube rating of the particular tube being employed, the time and milliamperage can be established. It must be borne in mind, however, that the above fundamentals and principles are only general—and at best can only serve as a guide on which one can base a technique satisfactory to his own requirements. After these factors have been taken into consideration, the trial run method may be employed to obtain the best results. Developing such films, of course, should be done in fresh solutions using the proper time and temperature. By following such a procedure, one should eliminate darkroom difficulties and confine improvement changes to the machine room.

After one has a certain amount of experience he will develop certain short cut methods in arriving at various techniques. Oftentimes it will be necessary to sacrifice or change already-established exposure factors. Applying the fundamentals, it is possible to change these factors as desired without the loss of film.

Technicians often apply these short-cut methods in fracture cases where it is necessary to X-ray through a plaster cast. A simple rule to follow in such cases is to double the time exposure factor ordinarily used in most cases. If this is not possible, an additional 10 kilovolt peak will usually bring about good results. If the cast has just been

recently applied and is still wet, it is often necessary to increase the kilovolt peak by about 6 or 8 over the ordinary amount of penetration.

In some instances, soft tissue of extremities is desired. In such cases simply use half the ordinary exposure time, or decrease the penetration value by 8 or 10 points.

Chest films of infants and small children usually require an increase, rather than a decrease, in penetration. An increase of from three to five kilovolt peak will usually suffice. When films are over-exposed, cut the developing time. There is nothing to do to improve the under-exposure, except to retake the view.

CHAPTER 16

Dark Room

Equipment—the first place to check for X-ray difficulty is in the darkroom.

a. Exclude all ordinary light; plug up any cracks in the wall, key holes, and around the doors. Ventilate the room.

b. Have sufficient developer—alkaline in nature, of proper strength and temperature—to completely cover the film. New solution should be of clear, amber color. Old solution is riley, muddy, and has a strong odor. Have a safe-light above developer; also darkroom timer at hand.

c. Use clean rinse water. Stagnant water will not rinse developer from the film and would result in hypo deterioration.

d. Use sufficient hypo "fixing bath"—acid in nature, temperature same as developer (65 to 68° F.). Fresh hypo is dark bluish-green in color. Worn out hypo is a light blue. Poor hypo causes reddish film stain. Provide ordinary reading box above hypo tank to examine wet processed films.

e. Tank should be large enough for film washing and must have running water. Insufficient washing causes films to become greasy. Temperature should not exceed 72 degrees.

f. Use drying rack or cabinet with an electric fan for circulation and quick drying of films. Locate drying rack

over wash tank so the water will drip from the films into the tank.

g. Room must be clean, free from dust; otherwise films will dry rough with dust and dirt. Using the drying cabinet, films always dry properly and will appear black, smooth and shiny.

h. Loading bench must be clean and as far from solutions as possible; otherwise solution may splatter on films or intensifying screens, which causes poor quality films and ruins the screens.

i. Rack for empty film hangers, all sizes, located conveniently above the loading bench. Have safe-light nearby.

j. Have leaded film storage cabinet near loading bench for unexposed films. (The lead should be at least one-sixteenth of an inch thick—one-eighth might be safer.)

k. A two-compartment, four-door type lead cabinet for storing loaded cassettes is convenient. This type permits the operator to load the cassettes and place in cabinet to be received from outside the darkroom.

l. Have indirect safe-light over head in center of room with bright light near it; both switches should be conveniently located just inside of dark room.

Steps in Procedure—a. Enter dark room. Turn on switch controlling bright lights. Place exposed cassettes on bench with the cassette covers toward you. Turn on the safe light over the loading bench.

b. Take down number of developing hangers necessary and place on bench near cassettes.

c. Remove covers from the top of solution tanks, stir and take temperature.

d. See that darkroom clock is ready for operation.

e. Close darkroom door and lock, unless using a two-way hall or approach for the exclusion of ordinary light. Turn off bright light, turn on the ceiling safe-light—located in the center of the room.

f. Walk to the loading bench. By this time your eyes will have become accustomed to the safe-light which is either red or green. Previously, darkrooms have been

painted black. But authorities now claim a lighter color is more suitable, for more safe-light is needed, but without any reflections.

g. Begin unloading the cassettes by the safe-light. Have the cassette placed flat on the bench in front of you, with the cover up, face down. Press down on the cover springs, usually two in number; raise and open with the left hand. At the same time lift the cassette frame with the right hand, keeping the hinge end on the bench. Then tip the cassette left—still maintaining approximately a three-inch separation between the cover and frame. This will allow the film to fall over against the cover. Then thrust the thumb and finger of the right hand between the cover and frame; tip the cassette to the right, and allow the film to fall against the finger and thumb. Take hold of the extreme edge of the film, allowing both cover and frame to rest flat on the bench. At the same time raise and extract the film without drawing it across the intensifying screens or the cassette frame. This procedure will make for the elimination of static marks on the film, which are caused by friction.

When loading the cassette, place it on the bench entirely open. Brush screen with camel's hair brush. Then remove film package from the lead cabinet, open and take out one film at a time. Be sure bright lights are off; safe-lights on. Films will be found between a folded piece of black paper. Holding the film so as to allow one-half of the black paper to fall away from the film, pick up the film at the opposite edge and permit the paper to drop entirely away. Film is then placed in the cassette carefully. The cover then is closed; make sure that both clips of the cover are properly locked in the cassette frame. Remember to place the cover back on the film box and return to the lead cabinet. Bear in mind that films are to be handled by their extreme edges only; otherwise finger prints will develop on films.

h. All exposed films should be removed from the cassettes and placed in the developing hangers at one time. Proceed then to the developing tank. Start the darkroom

timer, or note the time. Submerge all films in the developer as near the same time as possible, briskly shaking each film two or three times to prevent air bubbles forming on the negative, which would result in blisters on the developed film. Rubberized aprons should always be used to prevent the solution from splattering on clothing. The fixing bath, particularly, will eat holes in cloth and spot shoes. Be careful to allow solutions to drip in their original tanks. This is particularly important when taking a film out of the hypo to hold in front of reading box for examination before it has been sufficiently fixed.

i. In about a minute and a half to two minutes of development the films may be removed, one by one, to be examined in front of the safe-light. On the properly exposed film the image will begin to appear in about that minute and a half. If such is the case that particular film will not have to be viewed again, for it will develop in five or six minutes, **the proper developing time,** when using standard developer. If the image does not appear in that minute and a half you will know that the film was underexposed and will not develop into a good quality film—assuming now, the solution is efficient and of proper temperature. The over-exposed film will appear dark in the first minute and a half to two minutes of developing. This film should be retaken so as to develop full time.

j. Films are then removed from the developer and rinsed briskly, swished back and forth in the rinse water three or four times to rinse off the developing solution and then placed in the hypo or fixing bath. Be sure solutions are always efficient.

k. Here the film remains for 15 minutes to prevent film fading, and stain. Two to three minutes of time in this solution should sufficiently fix to enable one to examine it in front of bright light, with no ill effect on the film. **Replace film in the hypo for a total of 15 minutes.**

l. During extreme hot weather the chrome alum—a hardening agent in the fixing bath—may not be of sufficient quality to harden the film emulsion enough to remain

in the wash tank 30 minutes. To overcome this, additional hardeners are used. A satisfactory one is one part of formaldehyde to 60 parts of water. It should be used between the fixing bath or hypo and the wash tank. Submerging the film for a few seconds and then removing is sufficient to complete the hardening process. Remember, this added solution is only to be used when torrid temperatures prevail; otherwise the film emulsion would become rather soft and possibly sticky.

m. The films are washed 30 minutes in running water of not more than 72 degrees in temperature.

n. After films are removed, first swish them about in the tank, being careful not to scratch them. Then hang the films to dry near a fan which circulates the air in the room. Or use a cabinet dryer. When using the fan be sure the room is free from dust or films will dry rough.

o. Dry your hands thoroughly. Return to loading bench. Open the cassettes and reload them with unexposed films. Place cover on the film box, and return box to the lead cabinet. Thus the cassettes are placed in their respective place for use.

p. Ordinarily, films dry in approximately two hours. But the usual procedure is to remove the dried films the following morning, clipping off the corners and replacing the hangers in their respective places. Be careful not to scratch or mar the films.

q. The films are sorted, placed in their proper envelopes and then read.

In conclusion, keep your darkroom clean and tidy and eliminate all unnecessary lights. Keep film-developing hangers free from corrosion by the use of acetic acid. Processing tanks, particularly the developing tank, may also be cleaned with acetic acid. They must be thoroughly rinsed before adding new solution. A five-gallon container of developer, as well as fixer, if properly cared for (by maintaining proper and constant temperature, keeping it covered to prevent oxidation, and preventing chemicals coming to-

gether) will last for some time. It will care for possibly 400 or 500 8 x 10 negatives.

ARRANGEMENT OF MODERN DARKROOM EQUIPMENT

Place drying rack over wash tank. This rack is usually constructed of wood with notches to hold the developing hangers in place. Otherwise a fan on the films for quick drying might move the hangers and result in scratched or damaged films. This method of drying the films is just as good and obviously less expensive than regular steel cabinets with fan enclosed—commercially made film dryers. If using the rack and fan method the darkroom must be well ventilated, kept clean, free from dust and dirt, or the films will not dry quickly and the result will be dirty rough films.

The wash tank should be sufficiently large, connected with cold running water and have an overflow and drain valve. A lead-lined tank is the best because the solutions have no chemical effect on lead.

An 8 x 10 illuminator, or larger, should be placed conveniently above the hypo or fixing tank for reading wet films which may not be thoroughly fixed. This is not considered a proper spinographic procedure although it is done. The objection: one may interpret wet shadows incorrectly, particularly if it happens to be a border-line case.

The five-gallon hypo or fixing tank is perhaps the proper size for it eliminates a percentage of film scratching. All solution tanks should be kept in one large tank of water which can be heated to maintain proper temperature. Tanks should have covers to prevent oxidation. A tank of clear water should be maintained between the solution tanks so as to rinse the developed film before placing it in the hypo or fixing bath.

There are many types of developing tanks on the market. The best has a thermostatic control which keeps the solution at temperatures from 65 to 68° F.

Developing tanks are made in the same sizes as the hypo tanks.

The safe-light, preferably 8 x 10″ size with red or green shade, should be conveniently placed above the developing tank so that the solution from the films will drip back into the tank. This is a very important darkroom fixture, for a light which is not safe will fog or ruin the films.

Have a switch controlling the safe light or illuminator cver the solution tanks.

Place a shelf over the solution tank for the storage of mixed solution or replenisher.

Employ two or four door lead-lined cabinet for placing the loaded cassettes for use. The four door is the better type; two doors opening into the operating room—or the approach to the darkroom—the other two into the darkroom so that the cassettes may be received from either room. All unexposed films must be stored in a lead-lined cabinet or they will become fogged with secondary radiation. For complete safety it is advisable to line the wall between the darkroom and machine room with 1-16″ virgin sheet lead.

Sink with hot and cold water; also same to be supplied to large processing tank.

Use indirect ceiling safe-light, red or green shade. All safe-lights should have the same colored shades.

Have wooden rack notched for the suspension of developing hangers of all sizes, conveniently located above the loading bench.

Provide for loading bench with cupboards underneath. This bench must be as far as possible from the solution tanks.

Ordinary ceiling light.

Electric fan.

Small safe-light conveniently located over the loading bench.

Lead-lined storage cabinet for unexposed films.

Switch for ceiling and indirect light.

Open entrance with properly arranged partitions to exclude all ordinary light.

Red colored hall lights.

Switch for colored light over entrance.

CONSTRUCTION, AND DESCRIPTION OF MODERN DARKROOM

The darkroom is the heart and hub of your X-ray laboratory. Therefore, too much stress cannot be laid on the importance of its construction, proper equipment, and technical procedure, whether it be for the average spinographer in private practice or for one who conducts a general X-ray laboratory. As it is obvious that results depend entirely on the facilities and procedure used, equip it in a modern and scientific manner. The results will be evident in the speed, convenience, and quality of the work accomplished. Films may be saved or ruined in the darkroom, for spinography or radiography begins and ends there.

Directions and suggestions offered here are based on many years of experience and observation. If followed closely, consistent results will be obtained. An adequate darkroom, proper handling of the developing hangers and films, and the loading and unloading of the cassettes preparatory to developing and fixing are just as important as the actual placing of the patient, the exposure time, and the centering of the X-ray tube.

Manufacturers are constantly devoting time and money to the study of darkroom procedures because they are so important. Through constant research, new and improved devices are being developed to help the technician in the production of better X-ray pictures, and to lighten his daily routine.

Description—the location of the darkroom and its size are first to be considered. It should be within a reasonable distance of the X-ray machine. Plumbing and electrical connections are necessary, and ventilation is also a most

important factor. Very often darkrooms are made in small closets or lavatories, and in some instances they are in basements. Good results cannot be obtained, for confusion, little or no ventilation, dampness and other objectionable features make for poor end results. The construction of the darkroom must be of such material as to preclude leakage of ordinary light and X-rays. If this leakage presents a problem, the wall adjacent or facing the operating room should be lined with at least 1-16″ lead, for lead absorbs the X-rays. A lead-lined box, conveniently placed in the darkroom, is also necessary for the keeping of unexposed films.

The size of the darkroom is determined by the average amount of work to be done. Its minimum dimensions should still allow room for convenient and efficient procedure. The room must be kept clean, free from dirt and dust.

There seems to be a great deal of misunderstanding relative to a darkroom paint color. Heretofore, most X-ray laboratories used a jet black or other dark pigment. This theory concerning darkroom wall colors has been superseded by a more practical consideration, because of the type of filtration in the modern safe lights. With a lighter hue there is not only an increase in the amount of reflected safe-light and a safe visibility, but it will also eliminate wandering about in the "dark" darkroom.

Accessory equipment necessary in the darkroom: safe-lights, storage shelves, lead-lined cabinet, loading bench, developing hangers, hanger racks, solution tanks, rinsing and washing tanks, darkroom timer, solution thermometer, drying equipment, electric fan, brown gallon bottles for keeping extra solution, two wooden paddles, sink, camel's hair brush for brushing screens and cassettes daily, apron, preferably rubber lined, and other miscellaneous articles.

Safe-lights cause a large percentage of darkroom trouble. Fogging of the X-ray film is a phenomenon which in many instances is difficult to trace—that is, to determine whether it is caused by the safe-light, secondary rays, ordinary light, or chemical reaction. Actually, safe-lights are not

safe in the strictest sense of the word. All safe-lights will fog films by excessive exposure. In the final analysis, the maximum amount of safe-light intensity that may be used is determined by the following factors:

1. Safe-light film distance.
2. Safe-light filtration.
3. Speed of operation.

Factors one and three are external variables which may or may not be eliminated—due to the speed of operation. Naturally, the remedy is to proceed with the developing procedure as quickly as possible; then either increase the safe-light film distance, or reduce the safe light intensity or both, until fog is entirely eliminated. When red or green safe-lights are not safe at a given distance, they may be made safe by one of two things: either replace bulb with one of less wattage, or add to the density of the safe-light glass by interposing a piece of unexposed film or red or green paper between the glass and the safe light bulb. The size of the electric bulb in the ordinary safe light is 15 watts.

As safe-lights are not always safe, it becomes necessary, when using a highly sensitive film, to test it before attempting to proceed with the developing procedure. Place a metal object on a piece of unexposed X-ray film and hold same in front of the safe-light, at a distance of six inches, for about one minute. Develop the film. If the object appears on the film, the light is not safe. This method will also assure one as to the lights that are safe.

The above procedure should be the second check made in your darkroom. The first should be to check for the leakage of light through cracks in the wall, underneath doors or even through key holes.

One can easily clutter up his darkroom by having too much shelf space, much of which usually becomes a catch-all. However, some shelves are necessary for holding extra mixed solutions in dark bottles, a pitcher, glass funnel and an illuminator. The most convenient and suitable place

for such a shelf is over the developing and fixing solution tanks.

A lead-lined wooden cabinet for the storage and safe keeping of unexposed films should always be added to the darkroom accessory list. It is a most important factor, for it tends to keep the films from ordinary light exposure and will positively absorb secondary or static radiation so detrimental to unexposed film. This storage space should be located over or near the loading bench. Much precaution should be carried out in the machine room by having a lead lined exposed compartment, which may also be used to eliminate double exposure.

The loading bench should be large enough to allow for the opening of any size film package, as well as for the loading and unloading of any size cassette. If not large enough, film packages or even cassettes may fall to the floor and be ruined. The loading bench should be located as far from the solution tanks as possible. It must be kept clean. Any form of contamination may not only harm films to a point where diagnostic and analytical qualities are reduced, but it may also damage the intensifying screens.

Racks for modern film developing hangers should be built over the loading bench. Almost any material of sufficient size and strength may be used, but wood is perhaps the most commonly used because of its decorativeness. Each rack should allow hangers to hang parallel to each other. Its grooves must be of sufficient depth to prevent the hangers from dropping down on the bench. Film hangers are important in the darkroom. Their purpose is to keep the films suspended during development and drying. They must be kept clean and free from corrosion. Dirty and corroded film hangers will result in films with numerous finger spots or prints. Also, the corrosion eventually causes an annealment of the spring clips and this prevents the hangers from keeping the film taut or flat. Should the film bulge, or a corner of the film become unclipped during development, then developing is very difficult. This may

not ruin the film to where it will interfere with listing, but it will give the film a very poor appearance. Acetic acid solution may be used to remove film hanger corrosion.

Tanks for developing, rinsing and fixing should be of sufficient capacity to meet any situation. A cover should be supplied for each tank to prevent light and air oxidation which might deteriorate the developer. Such tanks should be capable of maintaining correct temperatures with maximum reaction to chemicals.

One of the most desirable and inexpensive pieces of tank equipment is the type operated by a compressor with sufficient refrigerant. This will automatically keep the temperature of the solution between 65 and 68° Fahrenheit. This range of temperature is necessary to proceed with proper development; otherwise films may develop foggy or too light. This compressor arrangement works this way: have copper coils submerged in a proper sized lead tank of water; connect the coils to the compressor, which is operated and controlled by electric current, with a supply of warm hydrant water to this large lead lined tank; then permanently place solution tank inserts therein. Correct temperatures will always be maintained. Such a procedure will add life and strength to the solution.

Films must be thoroughly rinsed between solutions. Immediately following the developing process, the film should be carefully rinsed in clear, running water of proper temperature by rapidly raising and lowering the hanger in the water for about 10 to 15 seconds. Too much time should not be used during this process as the film may continue to develop until placed in the hypo or fixing bath. If this should happen, a chemical fog may be produced by overdeveloping. In reality, the reason for rinsing the film is to prevent too rapid hypo deterioration. A rinse tank such as described above should be drained and cleaned frequently, or deposits of silver and developer from the developed films will prevent a thorough rinsing.

When the films are developed and fixation is complete, the films should wash about 30 minutes in running water.

The temperature of the water should not exceed 72° Fahrenheit and must be free from grit, grease or dirt, as it is very difficult to remove any of these once attached to the film surface. When washing films, be sure the water covers the hangers, as well. Films not properly washed will dry greasy. Many times this causes the films to crack, and although it may not materially interfere when reading the film, it gives it a very poor appearance.

A practical method to keep films suspended during this process is a wooden frame made to fit the inside and top of the wash tank. As this frame has grooves cut to fit the bar of the hanger, the films will hang completely submerged and safely parallel to one another—yet far enough apart for washing.

Following the washing process the films should be hung up to dry in a place free from dust and dirt, with plenty of air circulating around them. The time for complete drying, depends upon sufficient washing, the atmospheric conditions, humidity and temperature of darkroom. A suitable rack for drying, similar to that used for washing, can be permanently fastened to the wall and extended out and over the wash tank. This will allow the water to drain off the films and into the wash tank, rather than on the floor.

It is always advisable to maintain the proper solution temperature by other means than adding ice directly, which may produce excessive dilution. Avoid excessive heat in washing or the film emulsion may run. If the fixing bath is changed frequently during excessive heat periods, it will further insure the proper hardening of the emulsion. Sometimes the use of a cellulose sponge, to remove excessive moisture on the film, will aid in reducing the drying time, and thereby lessen the danger of emulsion run. Such sponges may be purchased from most X-ray accessory companies. If the X-ray film has been processed under normal conditions, a gentle swabbing with this soft durable sponge will not damage the film.

A hot darkroom and hot solutions only add to the many

darkroom variables which must be eliminated. Preliminary precautions are bound to produce a better quality of film.

The darkroom timer is a very important accessory, as it will add accuracy to the developing procedures. It should have a luminous dial with large figures; be sturdy and accurate, and of the interval type—to signal when the interval is concluded.

Exposures should be made so that films will develop a full five or six minutes, since the last minute of development in a suitable developer adds contrast to the X-ray films. This refers to standard solutions.

One of the most inexpensive and convenient ways of drying films is to circulate air around them with one or two electric fans. Ordinarily this method will dry films in less than one hour. Do not hang wet films above those already drying, as water dripping down on such films will spot them.

An accurate thermometer, properly calibrated, should be used when testing the solution. It is not advisable to use the type housed in wood, as the wood will absorb the solution, and testing from one tank to the other will eventually cause some contamination and deterioration.

Ventilation is very necessary to technicians continuously working in the darkroom. Ventilate by using one electric fan to circulate the air and another to draw the air out of the room. This necessitates a grill of some sort placed in opposite sides of the room to receive and discharge the air.

Never attempt to proceed with the developing process immediately following the mixing of solutions. The chemical dust in the room will fog films and the temperature of the solution will be too warm. Solutions should be mixed during late afternoon to be ready for use the following morning.

Adding new solution to worn out developer or hypo will not increase the efficiency of the worn out or deteriorated solution, for the new solution will be wasted. But adding solution to the tank to completely cover the films is a

necessary process. Keep the film entirely submerged while developing. Films not entirely covered will develop with a light blank strip across the entire film. So always have a quantity of mixed solution on hand. Keep this solution in dark gallon bottles, thoroughly corked to prevent oxidation which is produced by light and air.

Keep handy two large wooden paddles for mixing and stirring the developer and hypo. The use of one paddle for both solutions will cause contamination and deterioration —particularly of the developer for, it is the most sensitive of the two.

As these chemicals and solutions will ruin wearing apparel, one should wear an apron, preferably rubber lined, while working in the darkroom. If the solution splatters on your clothing, unremovable spots will appear, and many times these spots eat entirely through the clothing.

Procedure—Loading and unloading the cassettes and the handling of unexposed films and film packages involve definite procedures which must be observed to avoid desensitized areas on the film. Careless handling may produce finger prints, crescent marks, static lines and light fog. With bright lights off, the safe light on over the loading bench, proceed to open the film package which has been taken out of the lead-lined cabinet and placed on the work bench in the darkroom. Remove the cover of this package. Note that each film is placed individually between black paper, closed at one end. The entire amount of films in this package are between two separate pieces of cardboard. They are usually wrapped in black, then red waxed paper, and a piece of corrugated paper. From this point there are many ways to proceed. Perhaps the best way is to take out the corrugated paper, which will give the films more storage space in the box. It is not advisable to remove the waxed or black wrapping paper. They may eventually prevent light fog. As films are removed from the box, the wrapping paper should be folded back to its original position, cover replaced and the package returned to the lead-lined

cabinet. Incidentally, always store films in upright position.

The modern film holder, known as the cassette, is of metal, either bakelite or aluminum faced. It is not uncommon to find some technicians still using the old type, cardboard holder which usually is lead-backed. If using this type, allow the film to remain in the black paper and then place in the holder. When using the modern holder, the film is carefully removed from between the black paper and then placed in the cassette.

To minimize the possibility of abraision marks, transparent spots, etc., have the cassettes open, brushed out and lined up on the loading bench. Switch the bright light off, the safe lights on; remove film from box, then from black paper, being careful not to drag the film from between this paper to or slide film into the cassette. Place the end of film against the inside end of cassette, and thus allow film to gradually fall in place. Remember—always handle films by their extreme edges. A safe way to remove the film from the black paper is to take the film and paper in your right hand. With your left, lift one edge of this paper. Then fold it back and drop it until it falls entirely away from the film, except for that point contacted by your right hand. Now raise the opposite end of the film with your left hand. Release your right hand and allow the paper to drop to the floor, away from the film. Should you prefer to begin with your left hand rather than your right, you may do so. During this process, avoid kinking of films.

Having tested the solution and found the temperature to be about 68° Fahrenheit, you are now ready to proceed with the developing and fixing process. All the cassettes to be unloaded are placed conveniently on the work bench. The correct number of hangers are placed likewise. Everything is now in readiness. Latch the darkroom door. Turn off bright lights. Then allow two or three minutes of total darkness before lighting the safe lights over the loading bench and developing tank. Your hands are clean,

dry and free from perspiration. Unlock the cover of the cassette. Draw the cover back with the left hand. Raise and tip the cassette frame with the right until the film falls back against the thumb and finger. Allow the cassette frame to then rest on the bench. Next, grasp the film by its very edge and lift it out of the cassette carefully. While closing its cover with the left hand, hold the film with the right hand. Then pick up the hanger with the left and engage the film, making certain that your fingers only contact the film by its very edges and that the film is securely fastened in the hanger. Place the films and hanger in a more or less vertical position on the bench. Repeat this procedure until all films to be developed are in hangers. The films and hangers are then carefully placed one by one in the developing tank. Submerge them as quickly as possible and shake vigorously to prevent air bubbles from forming on the negative. Note the exact time.

Before continuing, it would be well to have a resume of what actually takes place in these chemicals, when the film is processed in solution at par strength, and according to prescribed time and temperature. When the X-ray film is exposed to the X-ray, a chemical transformation takes place which causes a re-arrangement of the silver salts in the film emulsion. Theoretically, the X-rays, as well as the screen's fluorescence, bombards and shatters these silver crystals. The force of this expulsion injures the surrounding crystals. The number and depth of the crystals broken in this path of destruction depends on the angle of impact and the amount of tissue resistance offered to the X-ray. The exact nature of this chemical change is not definitely known, although it is apparent that a reduction of the silver salts to something metallic is started by the X-ray exposure. However, a complete reduction is necessary. This is brought about and completed chemically by the developer, alkaline, and the fixing bath or hypo, the acid. These chemicals which have the power to reduce the silver salts to a metallic silver must have other characteristics as well. They must react with other

agents to produce and control the different gradations between white and black or soft and constrasting tones. Hydroquinone and metol are reducing agents with excessive speed. Potassium bromide is used as a retarder for hydroquinone. Sodium sulfate plays no important part in the actual developing process other than as a preservative. Without this ingredient the reducers would oxidize and rapidly deteriorate. Sodium carbonate paves the way, swelling the gelatine in which the silver salts are suspended, so that the reducing agents may act without loss of time. Therefore, sodium carbonate controls the speed of the developer.

Three factors control the life of the developer: temperature, age (oxidation and deterioration), and the number of films which have been developed. Some technicians contend that certain exposure or certain ages of developer require certain specific and individual developing time at a given temperature. But, no doubt, better results are obtained by a full five of six minute development at par strength and temperature. It is the last minute of processing in good developer that adds contrast to any X-ray film.

To further increase results, it is advisable to purchase developer, fixer, and X-ray films from the same manufacturer.

The hypo or fixing solution is the last step in completing the developing process. This solution performs two duties: first, it rids the emulsion of all unexposed or reduced silver salts; second, it preserves or treats the emulsion and prevents deterioration.

Five agents make up the hypo. Hypo sulphite crystals dissolve the unreduced silver salts. At full strength its action is very rapid. Alum is the hardener, which treats and preserves the emulsion. Sulphuric acid counteracts the alkali and immediately stops any further development of the film in the hypo. Sodium sulphite is the preservative. Chrome alum makes the solution opaque to ordinary light, so that the bright light may be turned

on almost immediately after having placed the films in the fixing solution without fogging the films. However, films must remain in the hypo or fixing solution for a total of 15 minutes to thoroughly fix and prevent stain and fading.

There are two ways films are developed. One by color, the other by time. With films in the developer proceed as follows: when developing by color, lift them out, one by one, and after about two minutes of processing hold in front of the safe light, about four inches away; note the progress, and then place back in the solution. The image on the properly exposed film will begin to appear in about one and one-half to two minutes of developing. Under-exposures will hardly appear in that time. The over-exposure may be black. Thus, it is necessary to look at the films being developed at least once and maybe twice during this process when developing by color. Taking them out too many times will slow up the developing process and, too, it may increase the possibility of fogging. Actually, the best results are obtained using the standard time method. If films developed too dark they are over-exposed—too, light, under-exposed. The correction should be made in the machine room. After the film is finished in the developer, it is rinsed quite vigorously in clean rinsing water and then placed in the hypo. After fixation, the film is placed in running water to wash for 30 minutes and then hung up to dry.

Realizing the importance of the darkroom procedure, here are a few darkroom hints which will step up the quality of your work.

Ordinary light fog produces black streaks on the developed film. It may be around the edges or it may be seen across the film. This type of fog may be produced by light rays leaking into the room; by not having the film package or box tightly covered, or by a leakage of the cassette itself. Sometimes it is necessary to reline the cassette with felt to keep it light-proof during the exposure.

Static lines are usually produced on undeveloped film

by drawing the film over an object or by pulling the film from between the black paper. On developed film these lines appear very fine and black, sometimes in a sort of fine network of lines. Such discharges may take the form of dots or specks and smudges rather than the delicate lightening-like lines frequently encountered. However, friction in handling is most always the cause of these markings. Therefore, delicate film handling is most desirable. Observance of the following precautions is not only helpful, but gratifying.

1. Remove film slowly from the package.
2. Let the inter-leaving paper fall away from the film.
3. Place the film in the cassette without sliding it on the screens.
4. Avoid pressure on the films.
5. Do not stack the films in piles before putting on the hangers.
6. Handle films only by the extreme edges.
7. Be sure the film is entirely within the cassette before closing the cassette.

Practically all difficulties can be eliminated by carefully adhering to these rules.

Yellow stains or a complete yellow tinge on a spinograph film is due to exhausted fixing solution. When the film is not sufficiently rinsed after development, it will carry some of the developing solution over into the fixing bath, neutralizing it. Then the chemical reaction causes these yellow stains. The only remedy is to mix new fixing bath and then properly rinse films before fixing.

It is claimed by some chemical companies that exhausted but not completely deteriorated fixer may be restored to fairly good solution by adding 20 per cent solution of sulphuric acid. The amount of acid to be added may be determined by first noting the color stain of a good fixer on a blotter, then adding enough sulphuric acid to the fixer to bring back the approximate tinge of the exhausted solution.

To improve the keeping qualities of unexposed nega-

tives it is advisable to store them in a cool place and in a lead-lined cabinet, as secondary radiation from the X-ray room, or even static, will fog them.

Exposed negatives may be submerged in a 10 per cent solution of alum for a few minutes to keep them clear and clean, and preserve them permanently. This operation takes place after the film has been properly fixed. Of course, it is necessary to wash the films after taking them out of the alum bath.

Those who operate in hot areas will encounter difficulty in storing and keeping unexposed films. Even to keep the solution at proper temperatures is usually difficult in such a climate. In cases when provision was not made for this difficulty, films have been found—even in the package—with the emulsion actually slipping from the base. Therefore, unexposed films must be kept in a cool place. Remember, films with tacky emulsion placed in a cassette for exposure will completely ruin intensifying screens.

If the unexposed films are kept in a cool place, developing may then proceed with little or no difficulty, so far as softening of the emulsion on the film is concerned. But to assure absolute safety, particularly in these heated areas, place the films in a solution of 60 parts of water and one part of formaldehyde for a few seconds after development and fixation. This will harden and set the emulsion to the base so that sufficient washing of the film will be possible. The alum bath, if used, should follow the formaldehyde.

For quick drying of films after development and fixation, they should be thoroughly washed in running water for at least 30 minutes; temperature of water should not exceed 72° Fahrenheit. Then the films should be removed from wash tank and placed in front of an electric fan. The room should be well ventilated; free from dust and dirt. A properly washed and fixed film should dry smooth, black and shiny.

High speed intensifying screens are generally used in spinographic and radiographic work. Films exposed with

intensifying screens are only as good as the screens permit them to be. Perhaps some increase in detail can be obtained with a medium speed screen. But there is a greater possibility of getting motion on the film with this sort of technique, and motion appearing on the film makes it useless. Great care should be given to these screens to make them last and give the best results. Dust and dirt should never be permitted to accumulate on the screen surface. The use of a camel hair brush is advisable in brushing the screens. Evidence of dust and dirt will appear on the developed film as minute white spots. Also, a laggy, worn out screen—or sometimes screens having excessive crystals in their emulsion—will reveal similar spots on the developed film.

It is always advisable to load and unload cassettes in the darkroom as far as possible away from the chemical solutions, although wet solution spots on the screen's surface can be readily removed with peroxide. But when such solution spots dry on the screen there is nothing which will remove them without damaging the screen's emulsion. Since modern screens are washable, they should be washed often enough to keep them clean. To wash, dampen a piece of cotton, use a little Ivory soap, and rub the screen very lightly. Be sure to remove all soap from the screen before drying. When drying screens, a tuft of cotton may be used and the screens placed in the sunlight. The sun will not only dry, but bleach the screens. Be certain the screens are thoroughly dried before using.

Solutions that have lost their strength will often produce stains. These may obscure details sufficiently to confuse interpretation. Before using solutions, stir them well with a wooden paddle and then take the temperature, which should range between 65 and 68° Fahrenheit. If an extra quantity of solution is mixed, keep it in dark corked bottles. This will prevent light and air from oxidizing the solution. It is not advisable to add new solution to old, except when it is necessary to bring up the level of the solution to cover the films.

CHAPTER 17

Protection As Applied to Routine Work in the Laboratory

In this chapter, remarks pertaining to protection refer directly to radiographic procedures. The methods may be regarded as practical, rather than scientific.

After many years of experience, the writer realizes this information relative to protection must be constantly given and stressed. It should be understood that he is expressing much of his personal opinions, based upon years of practice in the operation of X-ray machine equipment.

This chapter has been prepared especially for the benefit of students who expect to enter this field of endeavor.

The very first consideration is the rule of safety from a moral and legal point of view. It has much to do with the success of any X-ray laboratory.

Next comes the types of equipment. Should a non-shock proof machine be used, be sure all wiring is well out of reach. The tube should be enclosed in a lead glass bowl, and all equipment grounded to prevent the presence of static electricity. Though static discharges are not dangerous in themselves, they frighten the patient. This causes the patient to move during the exposure.

The next consideration is the ability of the operator to do this type of work. Though it has been said that the theory of X-ray remains as its discoverer found it,

methods of procedure keep constantly changing as a result of scientific research and experimentation. Thus, to do this work correctly, with all safety and caution, one must keep abreast of the times.

It is advisable to line the X-ray room with sheet lead, approximately 1/8" thick. If there are offices or dwellings on the floor above, the ceiling should be lined also. X-radiation, unless absorbed, travels a great distance and eventually results in more or less damage.

The maximum amount of rays which an individual may receive without ill-effect is difficult, if not impossible, to determine. It is generally understood that the milliampere-second-limit rule is only an average one.

Always use a proper filter to absorb the soft rays. These rays are injurious to the health of the patient. It is this type of radiation that, if not absorbed, sometimes results in the "burning of the patient," erythema, or Roentgen dermatitis. First aid: zinc oxide, though often the butesin pictate or protomeclein salve is advised when such conditions appear.

Some individuals are more susceptible to X-radiation than others. Too, some may be more susceptible at one time than at another. To make inquiry of the patient as to his recent exposures is always necessary.

Proper preparation and placement of the patient is necessary to avoid retakes. Proper ventilation, sufficient clean white gowns, and cleanliness of the operator are essentials in any X-ray laboratory.

It is always advisable to keep a record of the case from a standpoint of legality and technique. Developing the films immediately after exposure eliminates the embarrassment of the patient's return for retakes.

Proper equipment, complete accessories and minimum working time saves films, decreases danger and helps to eliminate motion on the films.

Protection of the Operator—During the early days of research and experimentation in the production of X-rays, nothing was known of the danger and effect of this radi-

ation on tissues of the body. Thus, many X-ray operators were severely burned because of direct contact with the X-rays. Some were injured to the extent of losing their hands, arm—and even their lives. The same was somewhat true, also, in regard to patients. Obviously, all this was largely the result of improper protection. Today, such casualties in radiographic work rarely happen.

Since the operator or technician is operating the equipment from day to day, month after month, he is subject to greater danger than the patients. Naturally, he should provide for himself all the methods of modern protection.

His greatest danger comes from the absorption of secondary radiation. This often causes a general run-down condition, resulting in anemia, lack of quality or quantity of blood; and it is also said to produce some degree of sterility. Some authorities claim that the reproductive germs, in time, may appear fertile; others still are of the opinion they will not.

Because of this radiation, the operator should protect himself by operating in a lead-lined booth or from the control panel outside a lead-lined room. The latter is called remote control. Observation of the patient and equipment is made through leaded-glass windows.

Secondary rays, though traveling in straight lines, strike and explode, or are absorbed. These rays usually travel in a straight line; yet they may come from any direction. So a protection screen could offer only approximately one-fifth protection.

Sales talks about the ray-proof tube should be taken very carefully. The purchaser usually gets the impression from such remarks that such a tube will protect him from secondary ray injury. There is no such radiographic tube on the market. If there were, the X-rays would be absorbed before their emission from the tube. Secondary radiation is the result of X-rays meeting with resistance. This happens, of course, when rays enter the patient's body. Such a ray-proof tube or leaded glass protection bowl only offers a small percentage of absorption.

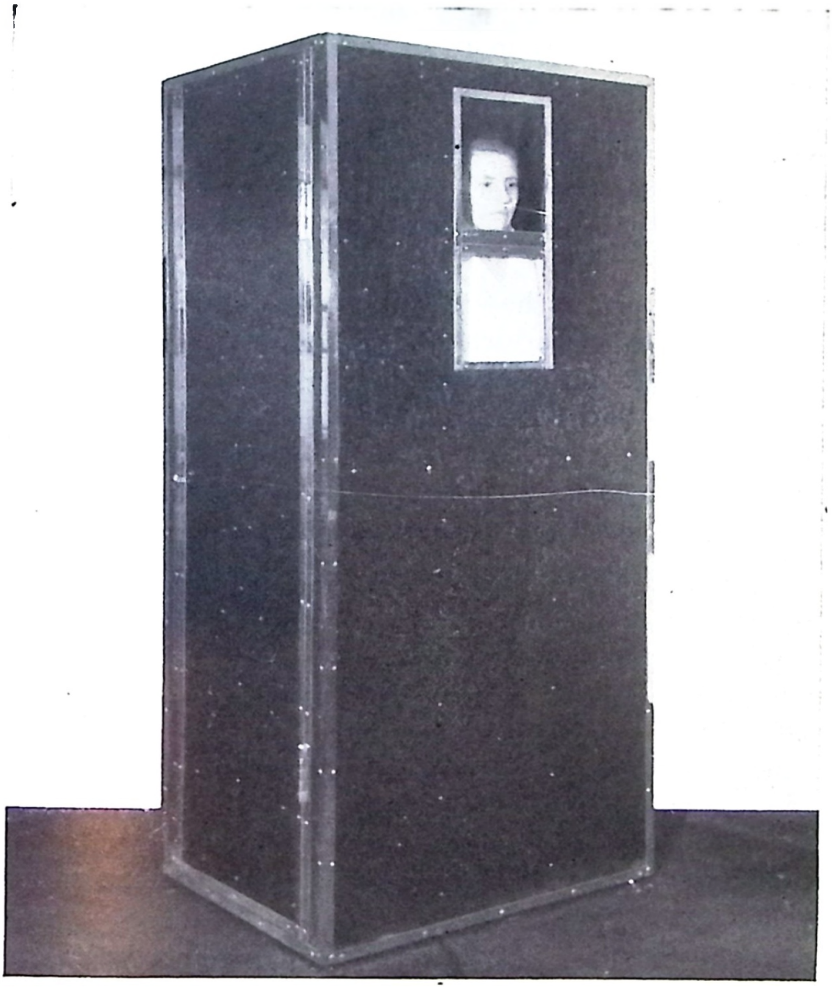


Figure No. 20
Operator's lead protection booth. Absorbs all radiation.

All high tension wires, even though insulated, should be kept well out of reach. Never leave the operating room with the machine running or attempt to make any repairs on the machine while it is plugged into the circuit.

The air, due to the ozone produced when using a mechanical rectifier, becomes more or less unfit to breathe. This condition necessitates a well-ventilated room. The operator must keep his hands away from direct radiation, and it is always advisable to work with the X-ray tube pointing away from the operator. The greater the distance between the operator and the tube, the greater is the safety factor.

Always operate the machine watching the patient through lead glass which has an equivalent of approximately 1/8" virgin sheet lead.

Before engaging the X-ray switch for operation, **stop, look,** and **think.** See that everyone present is out of danger in regard to direct rays, high tension wires, etc. **BE SURE YOU'RE RIGHT, THEN GO AHEAD.**

Protection of the Patient—Injury to patients who have been subjected to radiographic or spinographic work is ordinarily not so great as when they have been under the fluoroscope, or X-ray treatment. Nevertheless, danger does exist. It may be necessary to make a number of exposures in succession from other angles. Sometimes retakes may be necessary because of incorrect technique, motion, etc. Always be sure the safety limit is not exceeded at any one time. And if it has, wait for 10 days before making further exposures.

Practically all X-ray laboratories—particularly the exclusive ones in hospitals or sanitariums—have a set rule to follow in procedures. This is done for the safety of all patients; yet their first exposure is a trial picture. The second and third exposure are made to produce better quality work. It is often referred to as the "Common Rule in Practice."

In this rule due consideration is made of the following factors:

1. Idiosyncrasy
2. Age, weight, and complexion
3. History (referring to accidents, temperatures, and recent X-rays)
4. Placement
5. Nature and thickness of part
6. Tube distance
7. Kilo-volt-peak
8. Milliamperage
9. Exposure time.

Idiosyncrasy—quality of body or mind. This peculiarity enters into the making of a readable picture. Often one has to deviate from an ordinary procedure to one suited to that particular type of individual. This procedure may not be the very best, but it may suit such a case.

It always seems difficult to X-ray elderly or aged individuals because of the decreased resistance of the calcium in the bony structures throughout the body.

When the weight and thickness of the individual is known, one has an idea of the amount of penetration to be used. Complexion refers to the blond or brunette. Blondes seems to be more susceptible to radiation than the other type. Knowing all this, one can change his technique many times to make it safe for that particular type of patient.

Always inquire of the patient as to accidents; and if he has had recent X-rays; inquire of what region, also how many films were taken, etc. This will give an idea of the technique to be used. Then milliampere seconds can be estimated, preparing the way for safety in further exposures.

AFTER ANY PART OF THE BODY HAS RECEIVED THE LIMIT OF EXPOSURE IN MILLIAMPERE SECONDS, AT LEAST TEN (10) DAYS—OR EVEN MORE

—SHOULD ELAPSE BEFORE FURTHER EXPOSURE IS **GIVEN.**

Knowing the history of the case will often act as a guide in the placement for X-rays. This saves films, adds to the safety of the patient, and results in undelayed procedure.

Knowledge of the anatomy of the part to be X-rayed is a guide in reaching the conclusion as to what technique should be used for making a better quality of film in the least amount of time.

EXPOSURES WITHIN SAFETY LIMITS

It is absolutely necessary that the spinographer knows just how much X-ray exposure may be given to a particular body area at any one time, without exceeding the safety limit rule. Though some individuals are more susceptible to X-rays than others, 1200 milliampere seconds is generally accepted as the limit in radiography—based on a focal skin distance of 15″ using a one-millimeter aluminum filter. This value applies to all parts of the body except the head. Using the same amount of focal skin distance and the one-millimeter filter, the limit of head exposure is approximately 30 per cent less.

The number of milliampere seconds used is determined by multiplying the total number of milliamperes by the actual amount of time, in seconds. For instance, if 20 milliamperes were used for 10 seconds of time, it would total 200 milliampere seconds.

20 Milliamperes x	10	seconds=200	Milliampere Seconds
50 Milliamperes x	4	seconds=200	Milliampere Seconds
50 Milliamperes x	½	second = 25	Milliampere Seconds
25 Milliamperes x	1.5	seconds= 37.5	Milliampere Seconds

If 100 Milliamperes were used for 1/10 of a second:

100 Milliamperes x .1 second = 10 Milliampere Seconds

The kilo-volt-peak, tube distance, and the use of a proper filter are important factors and should be given due consideration in protecting the patient.

In dental radiography or skull work, or in a region where

the patient's hair is in line with the X-rays, much caution must be used to prevent alopecia or the "falling of hair."

Because there is a difference in permissible milliampere second exposures between the head and the other parts of the body, the following table is given. As there are so many combinations of factors in technique, naturally the focal skin distances vary. Thus, the first column covers the average skin distance in inches; the second gives the number of milliampere seconds that may be safely used with one millimeter of filtration in X-raying the head, and the third in X-raying the other parts of the body.

Focal Skin Distance (Inches)	Head (with 1 mm. aluminum filter)	All parts of the body except the head (with 1 mm. aluminum filter)
15	900	1200
16	1025	1368
17	1152	1540
18	1295	1728
19	1444	1920
20	1600	2136
21	1762	2352
22	1935	2580
23	2115	2820
24	2304	3072
25	2502	3336

REMEMBER—The operator is responsible for any accidents occurring which may be due to carelessness or ignorance.

Visitors should not be permitted to enter the operating room during the exposure work unless their presence is necessary. If they must enter, keep them away from the equipment.

Fluoroscopic work, ordinarily, is done in a dark room. Usually, such examinations are made by a physician. The technician usually prepares the patient and operates the machine, while the radiologist operates the shutters and adjusts the screen during the examination.

This particular phase of the work is always more or less

dangerous and should not be within the realm of the chiropractic spinographer. The fluoroscope must be grounded, and the patient assisted about in the dark fluoroscopic room. Then too, the operator must protect himself by the use of lead glass goggles, lead rubber apron, lead rubber gauntlets, for he is always in the direct path of the X-rays.

The repeated cautions in this chapter are not intended to frighten those following this profession, but rather to assist them with advice based on experience. While the operator must assume certain responsibilities these are no more than those required in many other vocations. Any worthwhile field of endeavor presumes a certain amount of responsibility.

CHAPTER 18

X-Ray Marker

Markers should not be just any small metallic object, but the regular manufactured article. It looks extremely unprofessional to mark the spinograph with a hair pin, nail, piece of bent wire or a small piece of lead to indicate the patient's right side. The use of such haphazard methods would never identify the spinograph. Further, markers should always have a particular and uniform place on the film so as not to obliterate parts of the structures and interfere with the analysis. The regular marker usually consists of an aluminum holder by which lead-mounted letters and numerals can be suspended.

Markers must include the patient's name, date, name of the laboratory or doctor making the exposures, and a serial number. This is a very important matter in legal proceedings. Films are not identified without proper marking. Should this information be written on the film and not embedded in the film emulsion, in all probability such evidence would be stricken from court records. Writing this information on the film is no more authentic than writing it on the X-ray envelope.

Two markers are necessary for flat or regular spinographic work. A third is essential in stereo spinography to designate the right and left stereo shifts. The patient's name and date, reading from left to right, should be

clearly seen at the top of the film; the other information should be seen on the side of the film indicating the patient's right side. Never place a marker on the left; it might confuse the analyst. Repeating: markers are used to identify and indicate the patient's right side, and should be so placed as to not interfere with the reading of the film.

Markers may be fastened to the cassette or bucky diaphragm with cellulose or adhesive tape. The upper edge of the top marker should be at least five-eights of an inch below the upper rim of the cassette; likewise on the side of the cassette.

Another method of film marking often used is to type the information on a small piece of paper which is placed inside the cassette between the screen and the film. But this is not as satisfactory as the regular marker. The type is small, compared with lead letters and figures, and not as clearly readable.

Remember, the X-ray marker is indispensable. The chiropractor, as well as any other practitioner viewing the film, would not know which was right or left—unless he could examine the patient's teeth or see the shadow of the heart or the kidneys. Even then, it might not be entirely possible.

PREPARATION FOR SPINOGRAPHS

Appointments should be made for two reasons: the patient will not have to wait, and laboratory technicians can then plan their work. When making the appointment, note the region or regions and the number of views to be taken. Enough time must be allowed between appointments so the next patient can be X-rayed on time. There is nothing more exasperating than to arrive for an appointment and then have to wait. It is understood, however, that emergency cases have priority. Other than that—except for a breakdown of equipment—patients should not have to wait. This is an important matter, for the patient values his time as much as you do yours. Having to wait beyond

his appointed time can mean a loss of business, to say nothing about an irritated and disgusted patient.

When the patient arrives he should be greeted by a receptionist. Immediately, or as soon as possible, he should be ushered to the proper place and be made comfortable. His case history should be taken in a private office. The usual questions include the correct spelling of the name; the address; the name of the doctor who referred the case; whether the films are to be mailed or called for; occupation; accidents; major illnesses and dates; if recently X-rayed, where and particularly what area of the body, and anything noticeably abnormal in gait or posture. All this should be typed on a technique card, or recorded when the case history is taken. At this point the fee is collected and a receipt given; or it may be entered as a part of the chiropractic service.

A serial number is given to the case and the patient's name, the referral doctor, date, and the number of exposures to be made are entered in the daily ledger. All this makes for positive identification and provides the facts needed for insurance cases and for legal proceedings, should they be necesary.

The patient is then taken to a dressing room, given a gown, if necessary, and told how to prepare for X-ray, and that the technician (who may be the office practitioner) would notify him just as soon as everything was ready.

The preparation for atlas-axis spinographs demands the removal of hats, dentures, hair pins, earrings, necklaces, glasses or spectacles—everything which would interfere with the picture. It is not necessary for patients to remove any part of their clothing except that which might extend up around the neck. For the lower cervical and dorsal spine, the clothing must be removed to the waist and a gown put on, with the opening down the back. When taking the pelvis, which should include the lumbar vertebrae, sacrum, ilia, coccyx and the pubic bones, patients must remove all their clothing, pins, etc., except stockings and put the gown on with the opening down the back. The shoes

should remain on until patient gets to the machine room for the lower spine or pelvis exposure; the shoes are then removed.

Next, the markers are made up, the film envelope typed; and the markers, envelope and technique card placed in readiness for the technician. He then picks them up and takes the patient to the machine room. First he measures the thickness of the regions to be X-rayed and writes on the technique card the technique to be used. Then he proceeds to place the patient.

The technician must be courteous and do everything possible to keep the patient calm. As the patient is being placed, it is necessary to explain why he should not move—that if he does, the work must be done over again. No one besides the patient and the technician should be in the machine room at that time, unless the technician works with an assistant or unless other help is necessary. Unnecessary people in the room at that time may excite the patient; and very often they are in the way of the operator.

After the exposures are completed the patient is returned to the dressing room (or he might remain where he is) and told not to dress until notified, which should be in about 15 minutes—assuming the films are to be developed immediately after they are taken. Keeping the patient prepared until after the films are processed is very important. Should a retake be necessary, or if additional films must be taken and the patient has gone, it means they must be notified to return. This is always inconvenient for both the patient and the laboratory; and sometimes when patients are notified to return, they never come in.

CHAPTER 19

Machine Operation

Step by Step

There are many X-ray machines on the market today. Comparing one unit with another, there is some—albeit slight—difference in operation. Fundamentally, however, they operate alike, for they all have the same basic parts. This step-by-step information will apply to some machines, it may not exactly fit another in a particular office.

1. **Snap on Wall Switch**—This permits the electricity to travel or flow from a main switch and pole transformer, into the machine. The current, usually alternating (AC), is 110 or 220 volts. It is stepped up by the machine transformer to 90 and 100— in some instances to 250 kilovolts—and also stepped down to a 6-12 volt filament circuit.

2. **Snap on Machine Switch**—This will heat the filament wire incandescently (often referred to as lighting the filament light) which produces electronic, negative particles. These particles strike the tube's target at a focal point at tremendous speed (produced by the electro-motive-force) and are cast downward. This phenomena is called X-ray or Roentgen ray.

3. **Set Milliampere, Pre-Set Meter**—This is done to indicate a certain amount of milliamperes or current. So without energizing the tube, the meter may be regulated to assure the number of milliamperes desired. In other words,

it is possible to know (after calibrating or charting the preset meter) that a certain figure on a dial means 20 MA; another, 30 MA, and so on.

4. **Set Control for Kilovolts**—Voltage is the electromotive force or the punch back of the current. It forces the current to flow or travel. Kilovolt means one thousand volts. To determine the amount of kilovolt peak for an exposure, measure thickness of tissue in centimeters, multiply by 2 and add 25 up to 31 K.V.P.

NOTE—When using non-shock proof equipment always turn off the filmament switch. The tube is then void of power while placing the patient. This assures complete safety, when using non-shockproof equipment. Though this type of equipment is obsolete, many are still in operation.

5. **Set Machine Timer.**

6. **Place Cassette (with film) in Bucky and Cock Bucky**—The bucky serves two purposes. First, it suspends the cassette with film during the exposure. Second, the movable grid in the bucky absorbs a high percentage of the secondary radiation which fogs films. Without the movable or stationary grid, spinal films would be of little value. To cock the bucky, the grid is manually pulled to one side ready to begin the exposure. When the time button is pressed, the grid automatically releases and the exposure begins. This grid operates synchronously with the exposure time.

7. **Set bucky timer**—This actually regulates the exposure time desired.

8. **Place the patient**—Placement made after the controls are all set eliminates confusion; there is less possibility of motion, and it seems to expedite the procedure.

9. **Step inside the lead booth**—Here is where the machine and panel and timer should be operated to assure complete protection for the operator.

10. **Press the timer button**—This begins the exposure. If possible, watch the patient through a lead glass window at this time. Should the technician or operator work with an assistant, he should watch the control panels during

the exposure for line drop or surge. In that event, he might be able to help maintain steady current. This would not be necessary if a stabilizer were used.

The writer wishes to further stress the necessity for protection from "X" radiation. During the pioneer days of X-ray development he received instructions from several doctors who had been injured reasearching X-rays. Some had lost their hair; others fingernails and even fingers. He recalls one prominent doctor who had 55 operations on his hands. Possibly others were afflicted less seriously. By 1930 many of the researchers in this field had passed on with malignancy.

The United States Army states: "It is a known fact that too much X-radiation may produce alopecia, dermatitis, skin ulcers, destruction of the blood cells, anemia or even leukemia and with possible deformation of the growing fetus." According to the National Bureau of Standards, at Washington, D.C., "the technician should occasionally submit to a blood count and if there is a reduction of white cell count of 2,000 or more there is indication of radiation injury."

Protect yourself and the patient at all times!

THE IMPORTANCE OF PLACEMENT

Spinography has advanced far beyond the mere projection of the outlines of vertebral segments. It provides for visualization not only of contours but of depths, densities and surrounding tissues.

No one should be content to heedlessly make placements and alignments for the penetration of the various parts without a set plan as to the roentgenographic quality.

Furthermore, precision provides for stability and accuracy in the anatomical relations. So performance in equipment and the planning of proper procedures provides for better spinographs and a more accurate analysis.

CHAPTER 20

Placement for Entire Spinal Column

(See Pictures at End of This Chapter)

How to place the patient properly is easier to explain than to understand. With all the angles, parallels and non-proportionate parts of the human body, it seems to be the most complicated phase of spinography. At the same time, it is most important. Placements not correctly made mean spinographs not correctly read.

At this point it should be understood that the film and tube must be in perfect alignment. That is to say, the rays must be directed to the lateral center of the film—whether the tube be 12 inches or 72 inches from the film, or whether the tube is angled from above downward or from below diagonally upward. This is the first step in keeping distortion to a minimum. This check should be made each morning before the work begins.

All X-rays of the spinal column (for chiropractic purposes) should be taken upright—either sitting or standing—when possible. This is to make sure the directions in the misalignment are at their extreme positions under body weight and improper balance; that curvatures under the same conditions have reached their lateral peak; and if muscle tension exists, it would be exaggerated with patient in the upright posture. To employ the supine position might relax the patient to a point where the analyst would not

see the segment in its most exaggerated misaligned position. The writer has measured misaligned vertebrae of a patient X-rayed in the supine position; then found one of these vertebra in the opposite direction when the spinographs were taken with patient in the upright position.

The entire spinal colum is usually X-rayed on a 14x36-inch film. To take it in 8x10 sections—except for the pelvis—would produce less distortion. Densities would be more even, and both contrast and detail would be increased. However, such a procedure would take more time, increase the possibility of motion, and would be more expensive. The pelvis should always be taken on a large film to show the pubis and both acetabula. Two 14x17 films would be ideal for the spinal column. There would be less distortion than when taken on the longer film and densities more even; therefore more contrast and detail. Besides, listings would be more accurately made and the films handled and filed more easily. Repeating: there should be no attempt made to list atlas and axis on a full spine or even a full dorsal film, because placement is different than for the upper cervical.

Properly made anterior posterior views are most important. However, laterals, obliques and views from other angles are necessary to make a complete listing. In upper cervical work the base posterior or vertex must be included. In some few cases the nasium, or even stereos, might be required. Anterior posterior and lateral views usually suffice in full spinal column X-rays, except for stereos in unusual instances. Most people normally carry their head in a rotation or lateral tilt, or both. So, when placing patients for the anterior posterior atlas and axis view, rotate their body manually to align certain constant points of the skull, rather than directly twist or turn the head. The head should always remain in its habitual position. Should lateral head tilt exist—have patient lean from the hips slightly to place the cervical spine parallel with the film. However, a very slight amount of lateral head tilt does not ordinarily interfere with making the analysis. It is possible where there is

extreme head tilt that all of it cannot be removed by having the patient lean laterally from the waist. So in that event some head tilt will remain which must be compensated for in the analysis. Then it is just a matter of moving the patient right or left to get the head in the center of the film. Regular atlas and axis equipment should be used to expedite the work and maintain precision.—refer to Figure No. 10, Mod. R. Cassette Holder

Placing the patient for full spinal column, his heels, ilia and scapula are used to make proper alignment with the film. The head remains in its true relation to the body. In other words, the patient's heels, hips and shoulder blades are in direct contact with the surface of the bucky table, with the chin pointing right or left at will. This naturally means the head is carried in rotation.

Check screens. Each pair of intensifying screens should be numbered with India ink so the number will be visible on the negative. Should it be necessary to weed out a bad screen, there would be no difficulty in locating that pair of screens. Though screens may deteriorate from usage they become damaged in handling.

The lanyard—is a small cord chalk line used to approximate tube distance and angles. It is a simple device, yet very important. Tie one end to the side of the tube's casing. This will indicate a point in line with the focal spot in the tube's target. Then tie several knots in the chalk cord to represent inches in tube distance ordinarily used. The cord should be about six and one-half feet long. Next paint a thin line on the outer surface of the tube's housing (this is the opening at the bottom of the tube's casing through which the X-rays pass).

To use the cord, place its end taut against some part of the skull or body, depending upon what views or regions are to be taken. Then raise or lower the tube and at the same time angle it until the cord becomes parallel and in line with the mark on the housing. This tends to keep the direct path of X-rays approximately at right angles to the surface of the film and at the same time in line with the

object to be X-rayed. This is an important step in making precision alignment, particularly when spinographing the atlas and axis.

Head clamp—an important accessory in precision alignment. It keeps the patient in proper position, without motion. Identical placements can be made. Spinographic equipment should include a Thompson head clamp.

See Figure No. 11

Lateral Cervical View—Patient assumes a comfortable, upright natural sitting position. The film is usually placed at the right side, parallel to that side of his face. However, it doesn't make any difference which side the film is placed at, as long as the procedure is convenient. The exception is when there is fracture, dislocation or pathology. In that event, the afflicted side should be nearest the film. The superior border of the cassette should be approximately one and one-half inches above the bridge of the nose or the tragus notch approximately one and three-fourths inches above the horizontal center of the film. Atlas should then appear in the lateral center of the upper third of the film. This should place the sella turcica about two inches below the superior edge of the film. Incidentally, the posterior anterior angle of a normal atlas is on about the same plane as the roof of the mouth. The lateral cervical view is more important than many realize. I have seen cases of fractured and dislocated necks that were determined only by the lateral and oblique views.

The marker is placed on the bucky or cassette in line with the front portion of the face. Tube distance is preferably 60 inches, providing the machine has this capacity. The primary or central rays are directed slightly posterior and approximately one inch inferior to the external auditory meatus. If a more complete view of the intervertebral foramen is desired, rotate the patient's body about eight degrees, bringing the front portion of the face closer to the film surface. This makes the view oblique rather than a

true lateral. The patient should be continually cautioned not to move, because the tendency during this procedure is to slump forward.

Diagonal view—This type of radiograph offers much more information in a stereoscopic manner than the regular flat spinograph. It is particularly useful in seeing depth of the variables concerning condyles, atlas axis articulations. It is also valuable when checking atlas rotation and examining fractures, dislocations, ankylosis and bony pathology. However, when only the flat view is taken, it does provide another angle from which to view the atlas and axis, etc. Often, certain conditions not apparent on the regular lateral or AP views are revealed on a diagonal spinograph. The diagonal film is difficult to read and requires much study of the lateral and AP before any decision is reached. Preparation is the same as the lateral view. Patient sitting upright is rotated about 35 degrees towards the tube from a true lateral position. The atlas and axis should appear in the median line in the upper third portion of the film. The central rays are directed on a level with the meatus of the ear—passing anterior to the left mastoid and posterior to the right or vice versa.

Regular or Natural A to P Cervical—Patient assumes natural upright sitting posture which should be on an adjustable revolving chair. The Model "R" with 8 x 10 bucky is most applicable for this work. Instruct patient to rotate or turn his head left, then right, and then to look straight forward. At this instant we believe his head to be in its normal carriage. At the same time he is cautioned not to move. Patient's body is then rotated manually to align the frontal groove or cupid's bow with the external occipital protuberance. Manipulate chair until these constant points are in center of film, keeping these constant points in alignment. Avoid straightening the head by manipulation. Move patient back and properly angle the bucky so patient's head and shoulders will contact bucky. Usually the superior

border or edge of the film will be in line with the top of the head.

Re-check patient for correct alignment by comparing the auditory meatus or the tragus of the ear on either side with the film surface. Again check head with the center of the cassette or bucky, then secure the head with proper clamps. Place cork, one and one-half inches or smaller in diameter, in patient's mouth. Tip the tube so direct or central rays will be at right angles, or nearly so, to the film surface. However, the tube angle may vary with the individual.

Raise or lower tube until the lanyard, indicating the path of the direct rays, is in line with a point slightly above the inferior and lower portion of the nuchal line or jugular process; and at the same time bisecting the diameter of the cork through the lower third. With placement completed, if the upper teeth appear to overshadow the atlas and condyles, simply lower the tube slightly, then change tube angle so the mark on the tube's housing will conform to the angle of the string. If the occiput is larger and lower than normal, keep head in natural position and increase the KVP about five points. In some instances it may be necessary to increase the exposure time slightly to penetrate the skull, in order to clearly read the atlas through the occiput. The condyles and lateral masses, including a portion of the orbital cavities, must be clearly visible in order to properly draw the correct basic and median lines so as to make an accurate listing. The anterior posterior view is the most important of all cervical spinographs.

Base Posterior (AP View)—The base posterior, as well as the vertex, was designed to prove atlas rotation. Considering lateral head tilt, the most superior transverse indicates the anterior rotation; the inferior transverse, the posterior rotation. It also determines atlas in relation to axis. All cervical sets should definitely include the base posterior or vertex.

Patient is placed in regular sitting posture. The bucky

is angled approximately 50 degrees forward and placed lightly against the crown of the head. This should place the atlas with its transverse processes slightly below the horizontal in center of the film. Head rotation is then removed manually. Head tilt also is removed, at least to some extent, by the patient leaning slightly right or left from the hips. Keeping atlas in the center of the film, the head is then clamped. Tube is angled so that the string, when taut (indicating the central rays), against the horizontal center line of the bucky representing the horizontal center of the film extends slightly below the chin, bisects the angle of jaw, and extends diagonally upward approximately one inch anterior to the external auditory meatus. Tube angle is approximately 45 degrees. Tube distance is about 32 inches. When possible, increasing the tube distance would add definition to this view. Incidentally, shockproof equipment must be used because the tube of a non-shockproof unit would be dangerously close to the patient's knees.

Vertex (PA view)—The vertex was first made to prove atlas rotation—and to provide safety to the patient, since there was no shockproof equipment at that time. Although the vertex will accomplish the same ultimate results, it is perhaps more difficult to make and, it seems, is never as clear and clean-cut as the base posterior.

Patient is placed in normal sitting upright posture, facing the bucky or cassette. The top of bucky is angled approximately 22½ degrees away from the tube, and the tube angled about 25 degrees. The bucky is then lowered until patient, when bending forward from the hips, can place his chin and nose lightly against the bucky, with chin at a point about three inches from the top of film. This, of course, is in using the 8 x 10 bucky. Head rotation and tilt are removed in the usual manner when patient bends forward. The tube is raised quite high and angled downward, so that the string extending from the tube, indicating the central rays approximately one and one-half inches below the center of the film, will bisect the mastoid and tube's

aperture. Tube distance will be about 50 inches, although it may vary in individual cases.

Nasium (AP view)—The nasium should never take the place of the regular A to P cervical view. It does not contain the necessary information which the regular A to P view reveals. It is more difficult to correctly read, and it is not as visibly clear as the regular precision A to P view. However, it is another view from another angle, which may be to some advantage in addition to the regular A to P view.

Patient is placed in a normal upright sitting posture, with bucky or cassette angled to touch the head and shoulders. Placement is the same as the A to P cervical view, except the occiput is placed to appear slightly above the horizontal center of the film. Patient's mouth is closed, and head clamped. Tube is then raised and angled forward so the string, taut against the horizontal center of the bucky or cassette, will extend slightly below the bridge of the nose and bisect the center of the tube's aperture. Tube distance is approximately 72 inches. Incidentally, bucky and string angles vary somewhat with the individual case.

To increase the efficiency in the proceduce of the spinographic analysis one should always proceed step by step. This tends to eliminate errors and retracing steps. Consider all points before final conclusions are made.

Spinograph Sections

Lower Cervical and Upper Dorsal (L.C.U.D.)—is the second section; atlas and axis being the first. Now all cassettes have approximately a one-half inch recess bordering that part which encases the film. The superior and inferior edges are used in placing the film correctly. So it must be remembered the film is one-half inch smaller than the cassette. Repeating—spinographs should be taken in the upright posture when possible.

The film is placed with the superior edge of the cassette about one-half inch above the lobe of the ear, with patient's mouth closed and chin elevated slightly. Ordinarily this will reveal the spinous of the axis down to the junction of

laminae of the 6th dorsal. The reason for seeing the 6th dorsal on this film is to be able to compare it with the 5th. The tube is centered over the first dorsal.

Usually the area between the 3rd and 6th dorsal is light, due to the sternum and heart shadow. The body thickness at this point, particularly of the male, is greater (more dense) and requires more penetration or more exposure time. If either were given, the light area would naturally become darker; but the already dark area would become black. However, centering the tube over the second dorsal and adding a fraction of time might darken this light area sufficiently to read. Possibly a better way would be to use a metal filter over the less dense part for a fraction of the exposure to increase the resistance at that point, allowing for the greater amount of penetration over the dense area. This would tend to even up the density on the film and result in an even amount of contrast. These filters should be available from distributors of X-ray accessories.

The spinal nerves emitting laterally between the vertebrae in this section supply the nasal passages, retina, teeth, eyes, larynx, thyroid gland, tonsils, bronchi, shoulders, arms and hands, heart, lungs and liver. The 5th dorsal is known as general heat place.

Lower dorsal (L.D.)—is the third section and takes in the spinous process of the 5th dorsal, including the junction of laminae of the first lumbar. This time the inferior edge of the cassette is placed approximately three and one-half inches superior to the crest of the ilium. This should reveal the junction of the laminae of the 1st lumbar, including that of the 5th dorsal. Occasionally 13 dorsals or six lumbars are suspected. In that event take the 14 x 17 pelvis. Then the lower dorsal segment can be listed from the lumbar pelvis view. There must be an overlapping of the 5th and 6th dorsals on the L.C.U.D. and lower dorsal films in order to compare and list these two vertebrae.

There should be no difficulty in taking this view because body thickness is usually about even. More penetration is needed, however, this area being actually more

dense. Tube is usually centered over 9th and 10th dorsal.

The nerve supply in this area is to the stomach, pancreas, spleen, kidneys, ureters, serous circulation, etc.; and indirectly to the eye balls, tonsils, palate, salivary glands, etc.

Lumbar—is the 4th section, and ordinarily the easiest of all sections to take. This time the lower edge of the cassette is placed about two and one-half inches below the crest of the ilium. This will show a part of the 12th dorsal and the 1st tubercle of the sacrum. Again, your attention is called to the overlapping to be able to compare and list the 1st lumbar. Tube should be centered midway over this area. Nerve supply throughout this area is to the small intestines, legs, peritoneum, sexual organs, bladder, appendix, colon, rectum, etc.

Sacrum and Coccyx—this is the 5th section. The superior border of the film is placed one and one-half inches above the crest of the ilium. This view should reveal the 4th and 5th lumbars, sacrum and coccyx; also the symphysis pubis. The nerve supply is to the rectum, anus, uterus and thighs and legs.

Full Spinal Column—can be taken on one 14 x 36 inch film or two 14 x 17. In many ways the latter is more satisfactory: There is less distortion; films are exposed with a more even density which provides for greater definition; placement can be more correct, and the two are more easily made and easier filed.

Position—should be upright, though there are times when the supine posture must be employed. A cotton gown is substituted for the patient's clothing. Shoes should be removed. Placement and technique for both upright and supine, including the use of both size films, are as follows:

Standing (14 x 36 inch)—Patient placed with second tubercle of the sacrum and the spinous of the first dorsal over center line of the table if possible. This should ordinarily place the scapulae and the posterior superior spines in contact with the table top. Should patient have leg deficiency causing the spine to be diagonal rather than par-

allel with the center line, something should be placed under the short leg to parallel the spine with the table. It must be understood, however, that the weight of the body must remain toward the side to which the body leans. The head should remain in its normal carriage. The heels slightly separated and, if possible, against the table. Should this make the patient uncomfortable, place heels forward slightly but parallel with the table. It is also a good plan to have the table leaning backward very slightly to help keep the patient from moving. This backward tilt must be very slight so as not to take any weight off the feet. Head clamp can be used but we prefer not to use immobilization bands which have a tendency to pull the patient to one side, possibly interfering with the analysis. Tube is centered midway to the length of the film or slightly towards the heavier tissue. Use the lanyard and keep the direct path of X-rays right angled to the film surface as much as possible. Be sure the exposure covers the entire film. Remember, there should be no attempt to read the upper cervical on a full spinal column film because the placement for the two areas are different.

Standing (two 14 x 17)—This is the better method, providing the patient remains fixed or still throughout the two exposures. This is not a difficult task if the patient understands he must remain still and the exposure is not delayed. As previously stated, this procedure eliminates some distortion and adds contrast and detail to the film. Placing the patient is the same in both instances. The section to take first is a matter of choice. However, the procedure may be expedited by taking the dorsal cervical film first. Place top edge of the cassette slightly above the lobe of the ear, with patient's chin elevated slightly. This should reveal the spinous of axis. Use skin pencil and mark the skin at the patient's side to indicate the bottom edge of the cassette. This may or may not reveal all the first lumbar vertebra. For the second exposure or pelvic section, place cassette so it overlaps the skin mark at least two and one-half inches. This should include at least the

12th dorsal and the pubic bones. However, with some individuals there may be more of the lumbar vertebrae on the dorsal section; and, with others, more of the dorsal vertebrae on the lumbar section. Tube is centered midway to the long axis of the dorsal film, but over the 5th lumbar for the pelvic film.

Supine—preparation and placement are the same insofar as the median line of the table is concerned. Sand bags are used to keep the head in its normal posture. The body is parallel to the surface of the table. This position is often uncomfortable to the patient, and in that event something should be placed under the knees to elevate them slightly. There would be a change in technique because the viscera shifts laterally in supine position, offering less resistance to the X-rays. Less KVP and less time should be used.

Lateral full spine—May be taken upright or supine. Upright is more proper. Preparation is the same for either position. Tube centered slightly above the long axis of the film. It is almost impossible to take a true and readable lateral of the entire dorsal spine because the density and resistance through the shoulders is more than doubled.

Stereos—two films exposed off center and can be taken of any region. After processing they are superimposed in the stereoscope to see depth or third dimension. Tube shift at 30 inches is one and one-quarter inches left of the median line, and the same right for the second exposure—making a tctal of two and one-half inches of separation, or the total distance between pupils of the eyes.

The following is the ratio of tube shift and tube distance:

Tube Shift	Tube Distance
2½	30
3	36
3½	42
4	48
4½	54
5	60
6	72

Both films and cassettes are placed as usual in the bucky diaphragm. To identify the tube shifts, the letter "L" is placed in the marker on the film at the patient's right side; the letter "R" on the other film to indicate the right tube shift. Patient placement and technique are identical to the regular flat view.

To read the AP Stereo set, the film marked "R" is placed in the left illuminator with the marker nearest the reader. The one marked "L" goes in the right illuminator with the marker away from the reader. The two mirrors are manipulated until the two films superimpose, or until only one film is visible.

Tube Tilt in Tube Shift

The tilting of the X-ray tube in stereoscopic technique has not been generally accepted and carried out in the spinographic laboratory because it requires specially-built equipment. In other words, equipment in which the tube angles separately from the tube arm itself is needed. Some of the new equipment incorporates this, but in many of the older types of equipment, the tube only tilts with the tube arm. So in many instances, this becomes added work and only complicates the entire procedure with little or no advantage gained. Further, it is often found that when using some bucky diaphragms, the tube shift plus the tube tilt will cause grid lines to appear on the film. And though such films are not always detrimental or difficult to read, they are sometimes quite annoying.

Unless the angle of tube tilt is in accordance with the tube shift, depth is eliminated and the film will not fuse. Therefore, elongation in distortion is generally produced. However, if such manipulation of the tube is actually carried out in a precision-like manner, the percentage of depth will increase.

The tube tilt in stereoscopic work should be made in such a way that the direct rays or central beam, after the tube is properly shifted, are centered to both films in the same manner. An ordinary localizer, attached to indicate

the direction of the direct rays—or a small hole drilled through the center of the filter disk which permits a beam of light, or even a small flashlight throwing a small spot—will enable the technician to find the center of the film or bucky. Once the angle is determined, it is not necessary to repeat the process, unless a different tube distance is used.

Markers—A marker is always placed on the AP film at the patient's right side. This has been customary among X-ray technicians to determine the right and left side of the image on the film, and also to identify the film. Then when the film is read, the marker will be at the right side of the reader.

For the lateral film, the marker is not so important except for identification—unless pathology exists. When the right shoulder is towards the film, and the marker is in line with the front of the face, you know when viewing the film, that you are looking at the right side of the case. If left shoulder is towards film, place marker in line with back of head. Then you will know the left side of case will be seen.

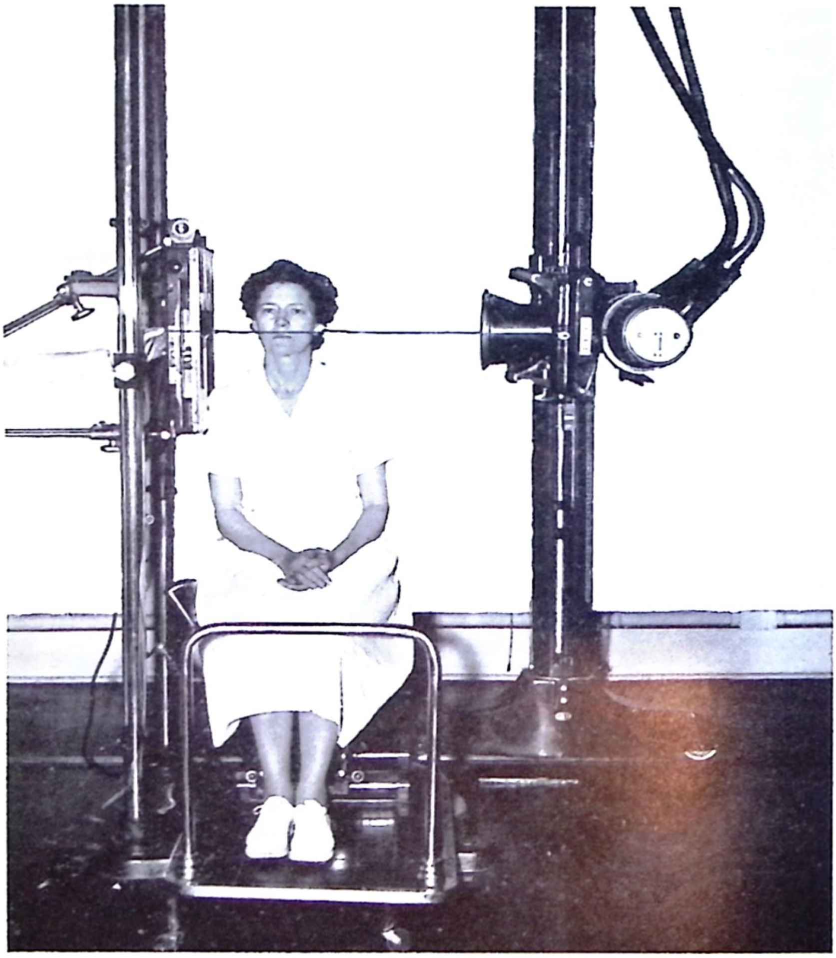


Figure No. 21
Lateral Cervical

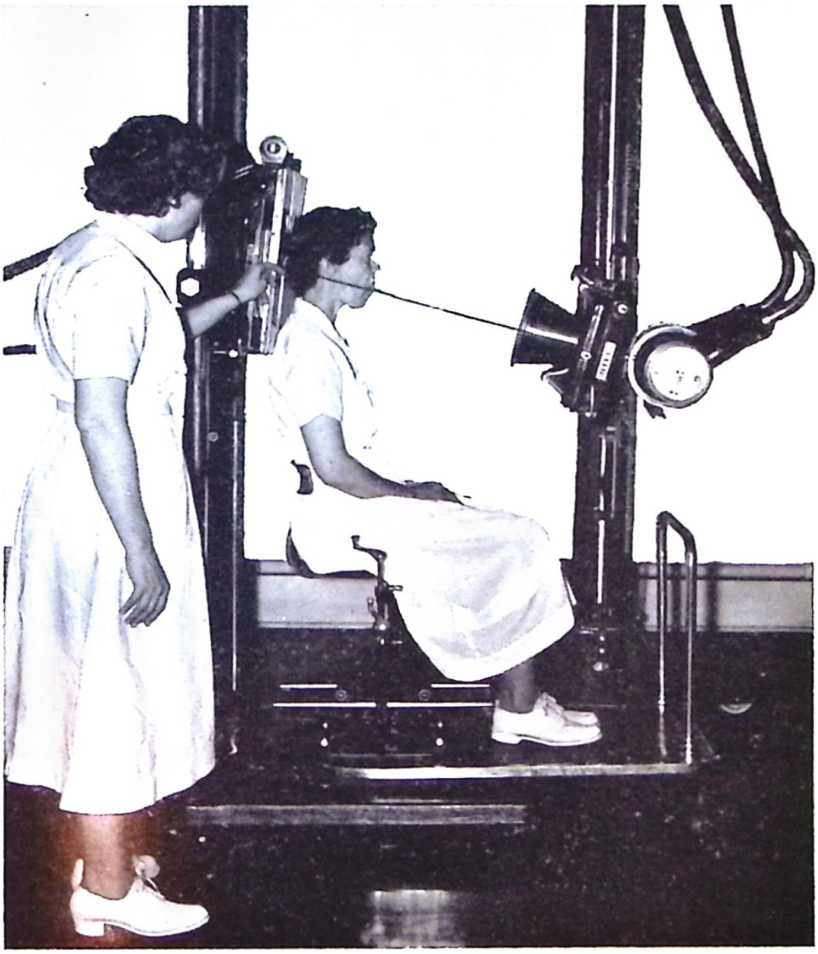


Figure No. 22
AP Regular Cervical

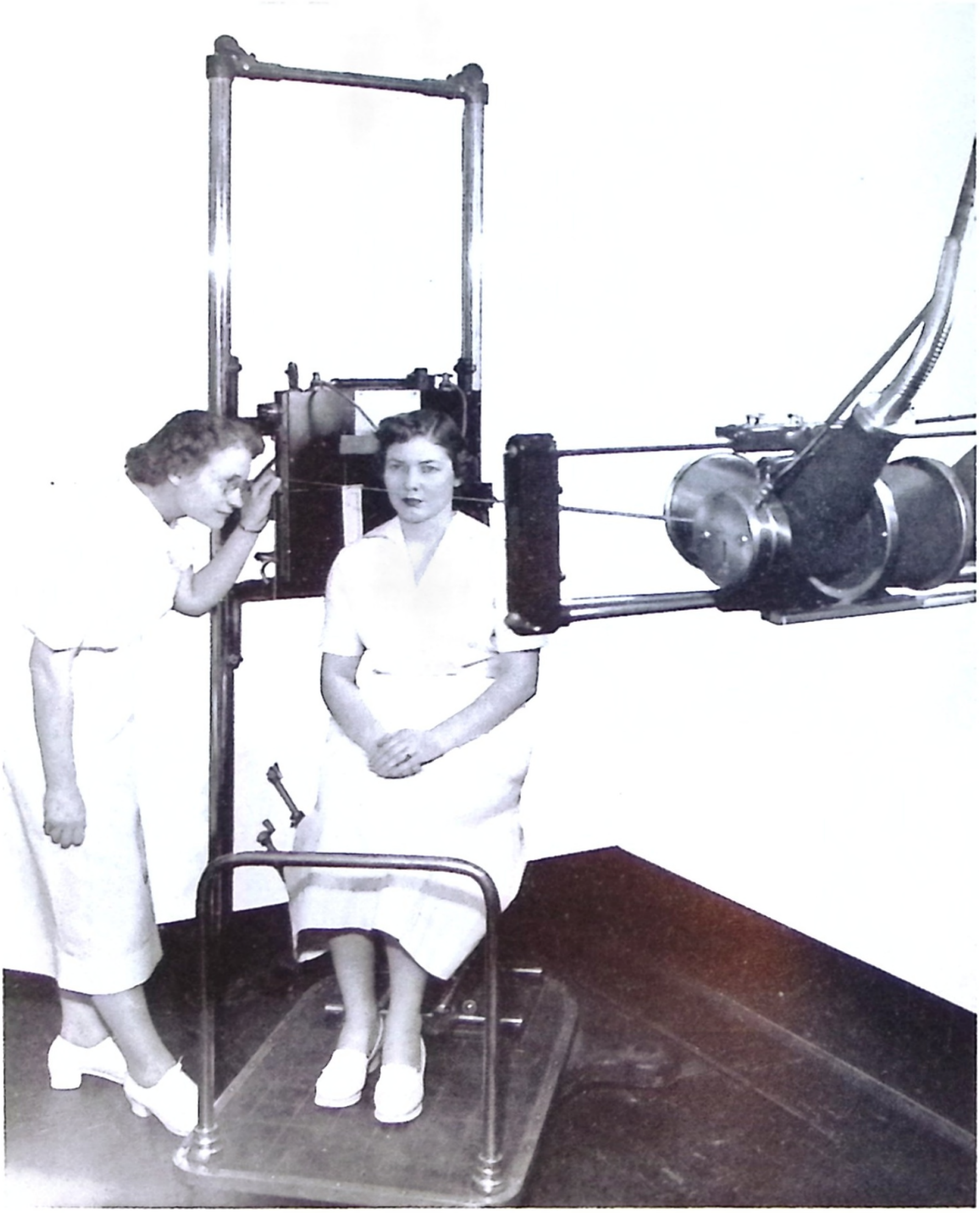


Figure No. 23
Diagonal Cervical Placement

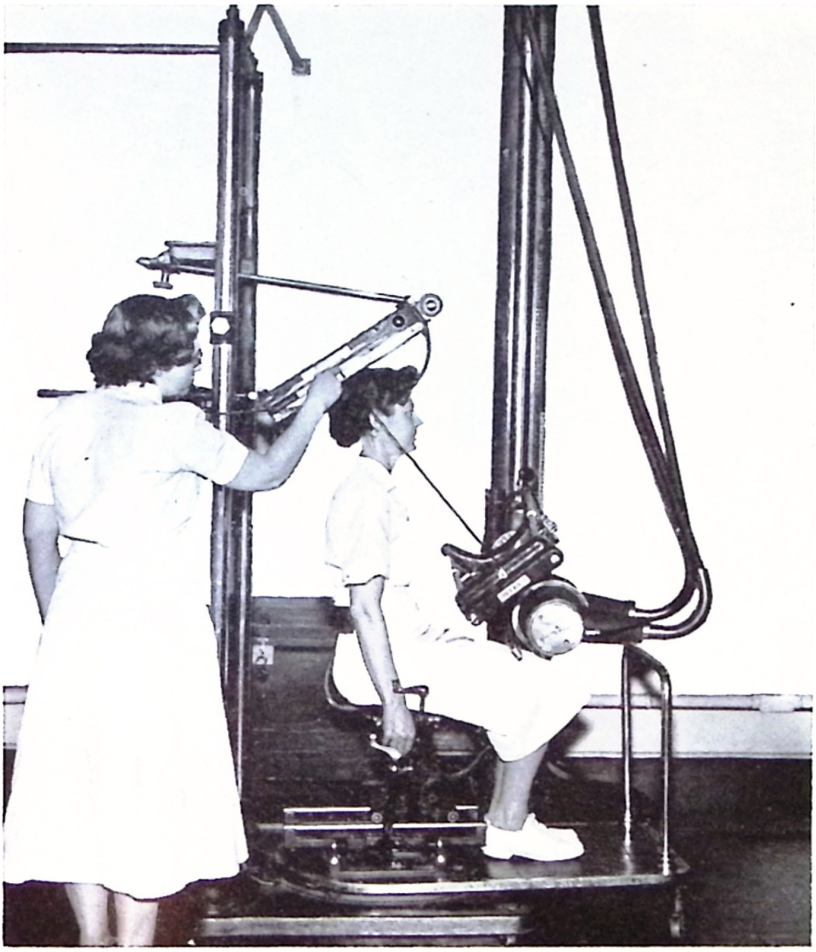


Figure No. 24
Base Posterior Cervical

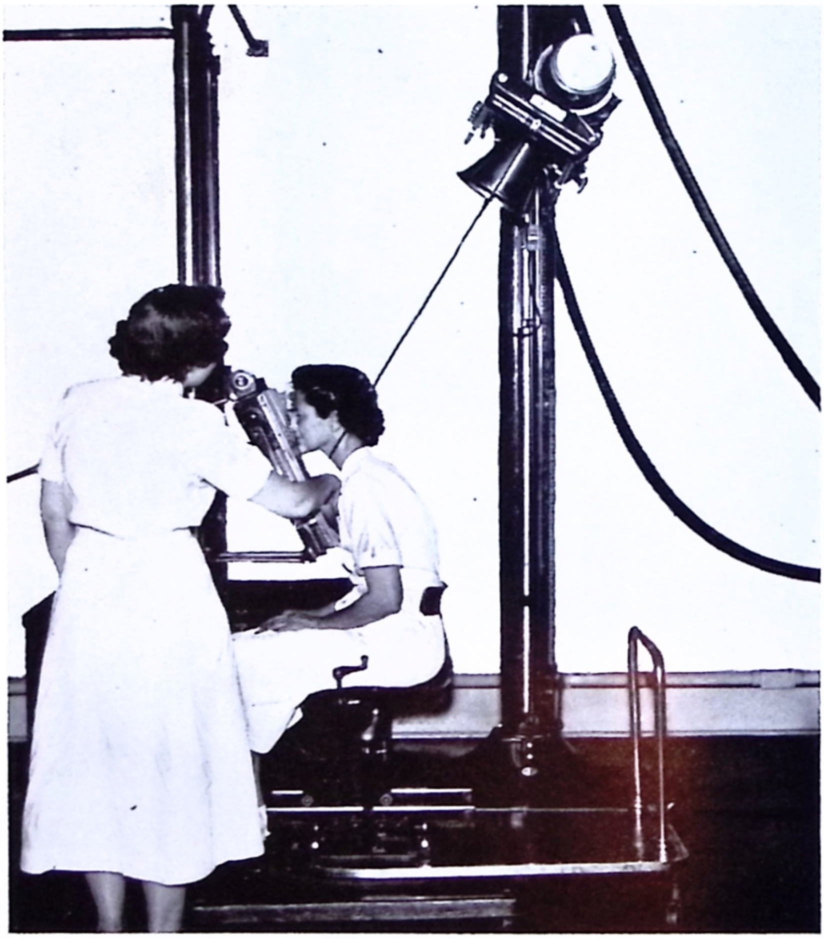


Figure No. 25
Vertex Cervical

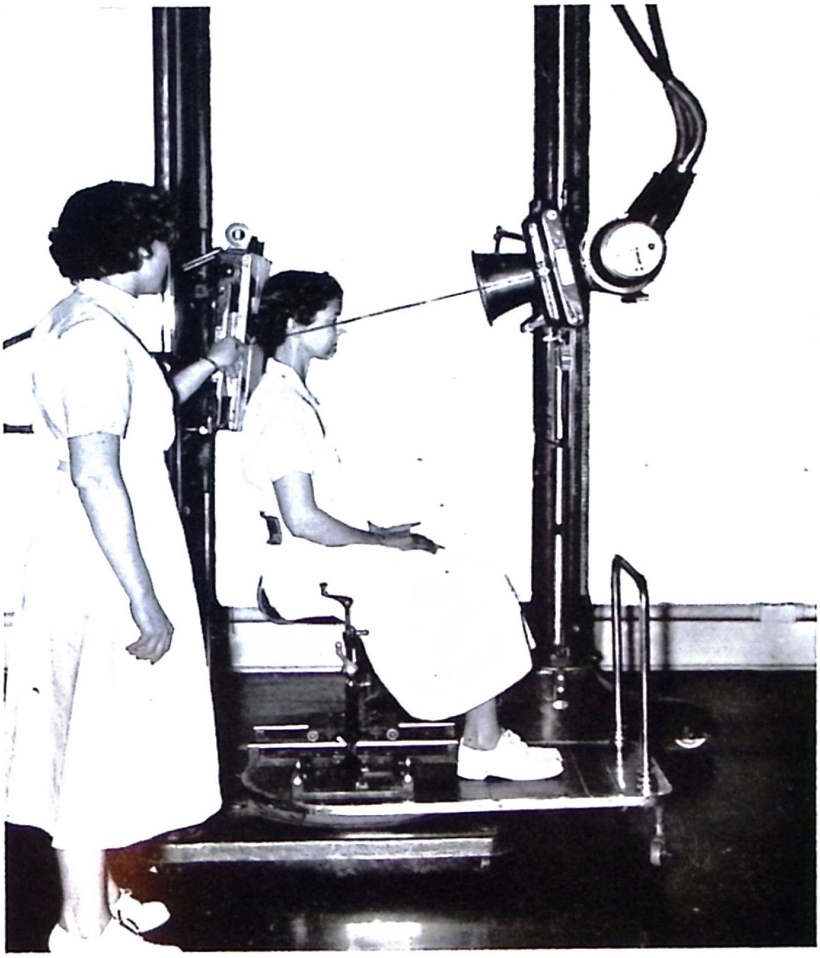


Figure No. 26
Nasium Cervical

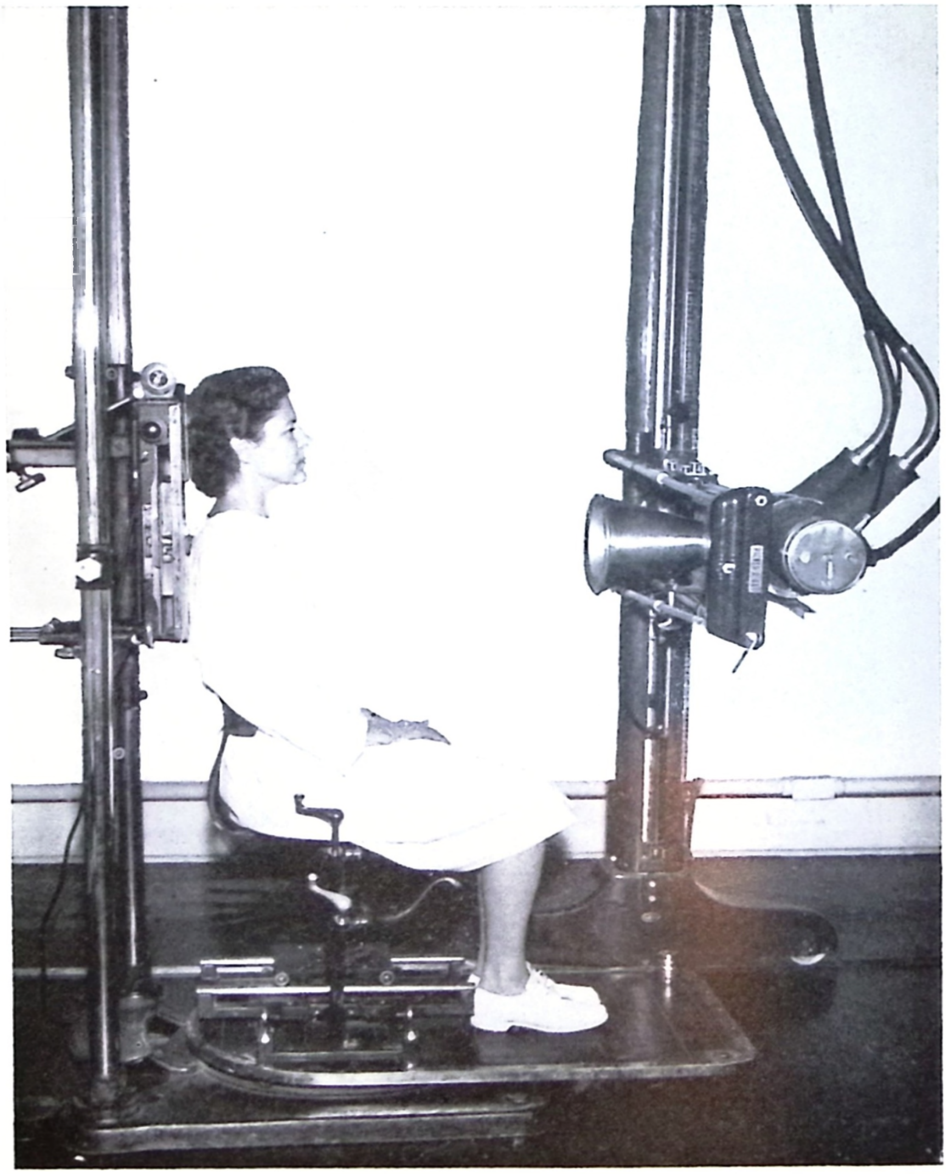


Figure No. 27
Lower Cervical and Upper Dorsal (L.C.U.D.)

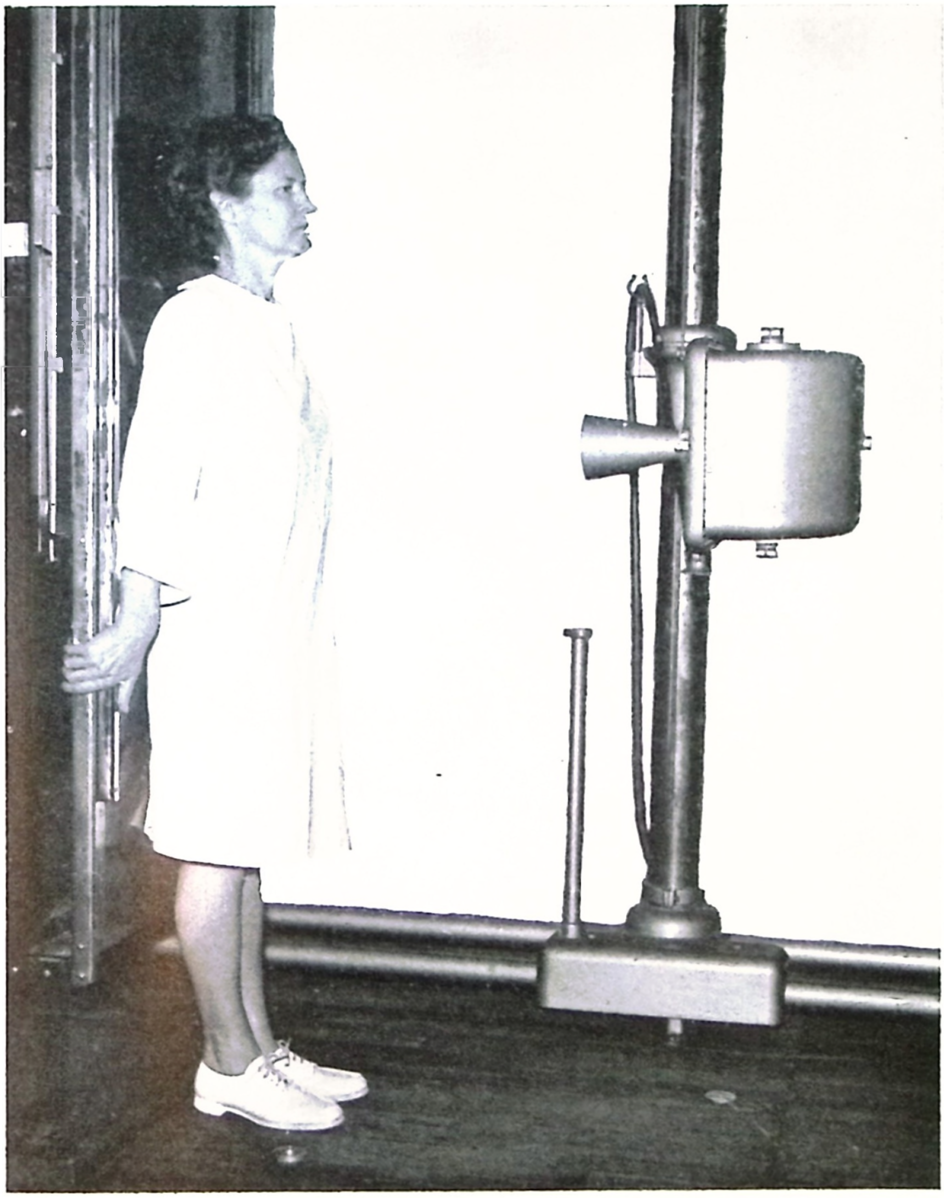


Figure No. 28
Lower Dorsal

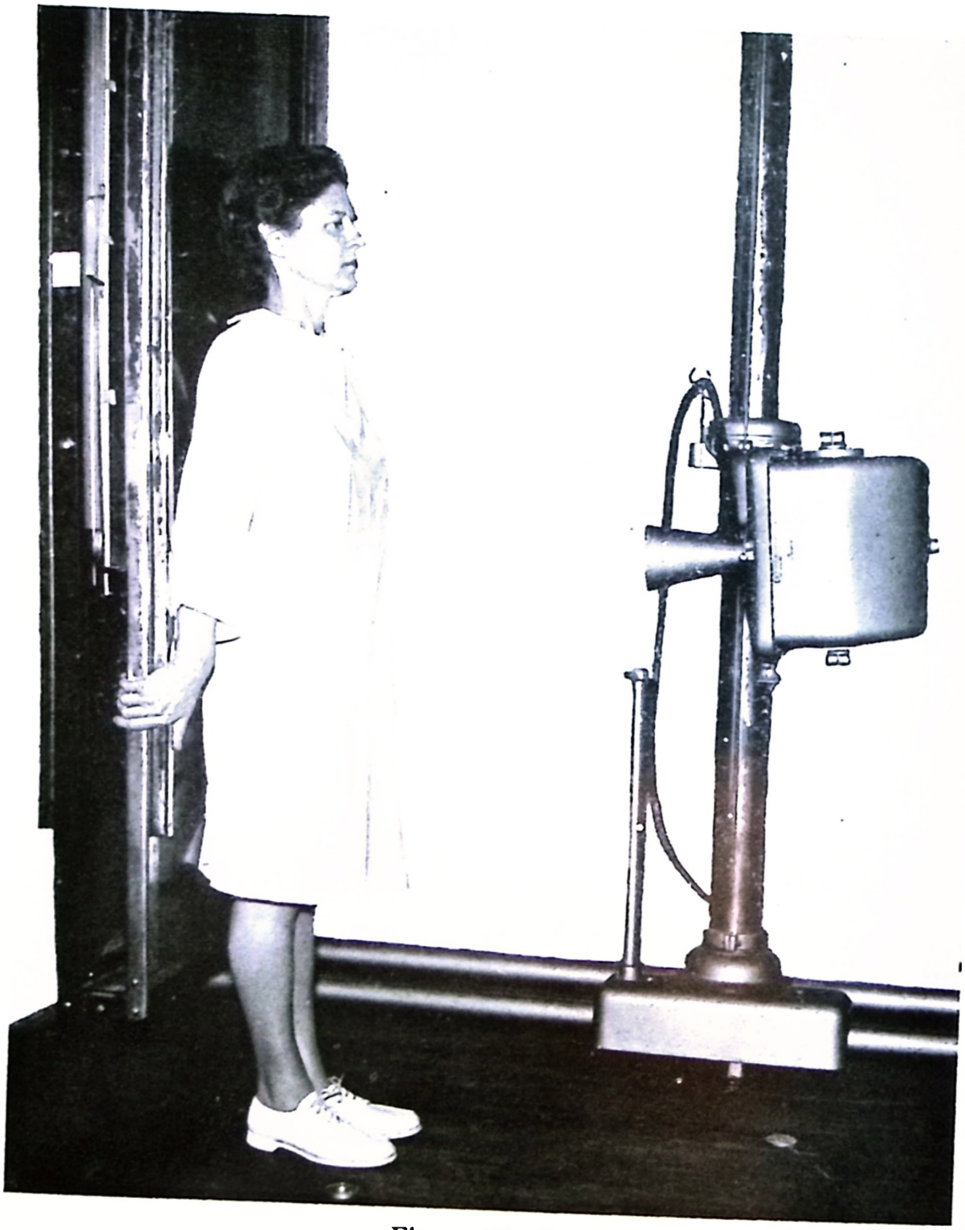


Figure No. 29
Lumbar

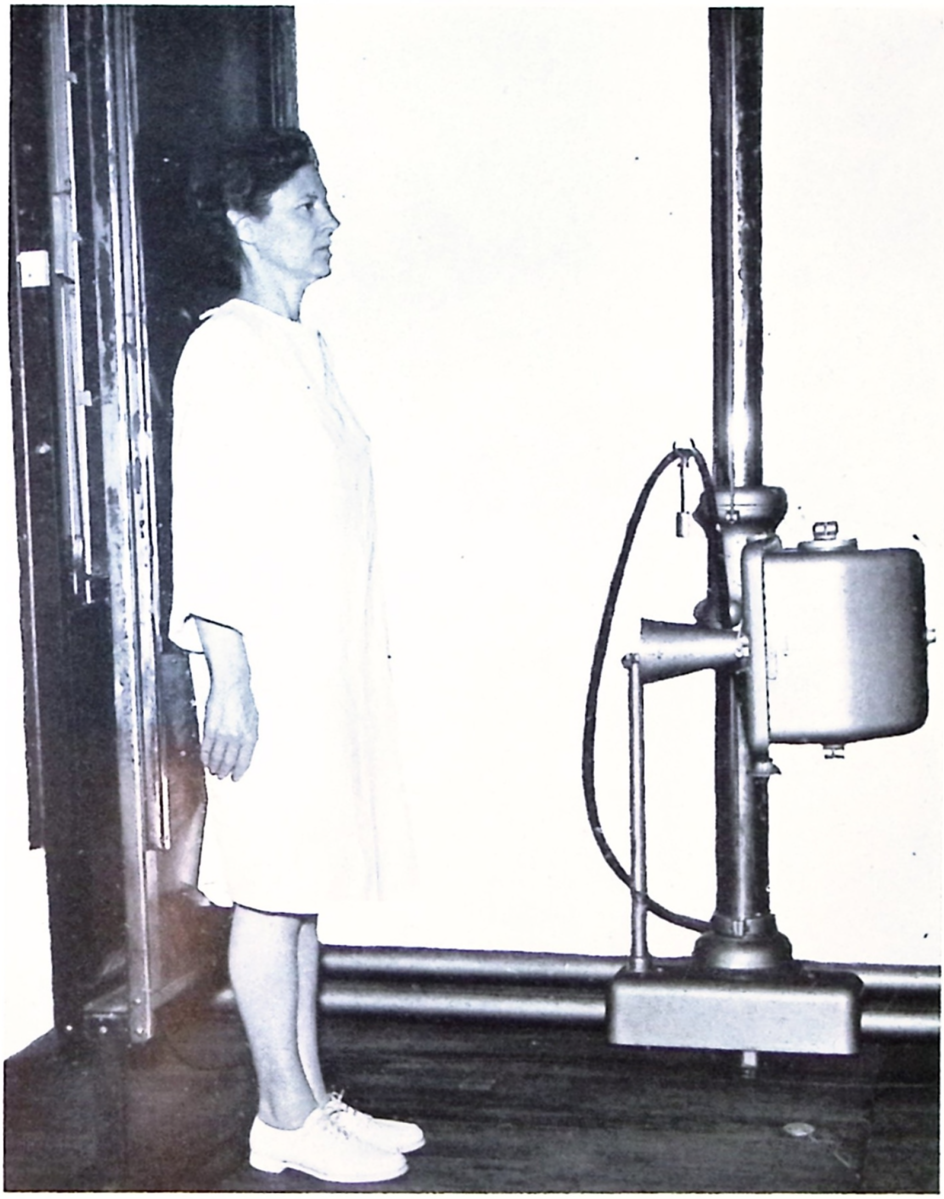


Figure No. 30
Sacrum and Coccyx

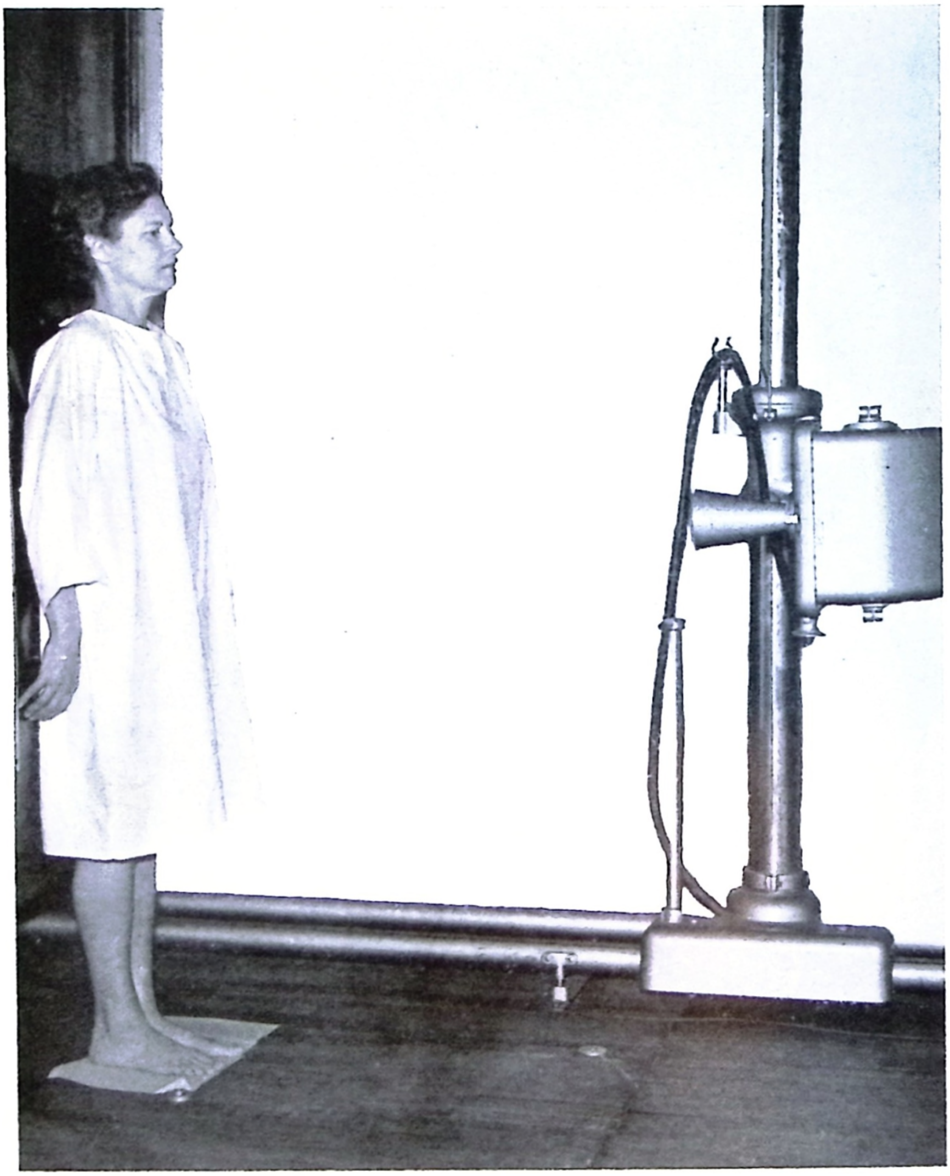


Figure No. 31
Full Spine—14x36—AP View Standing

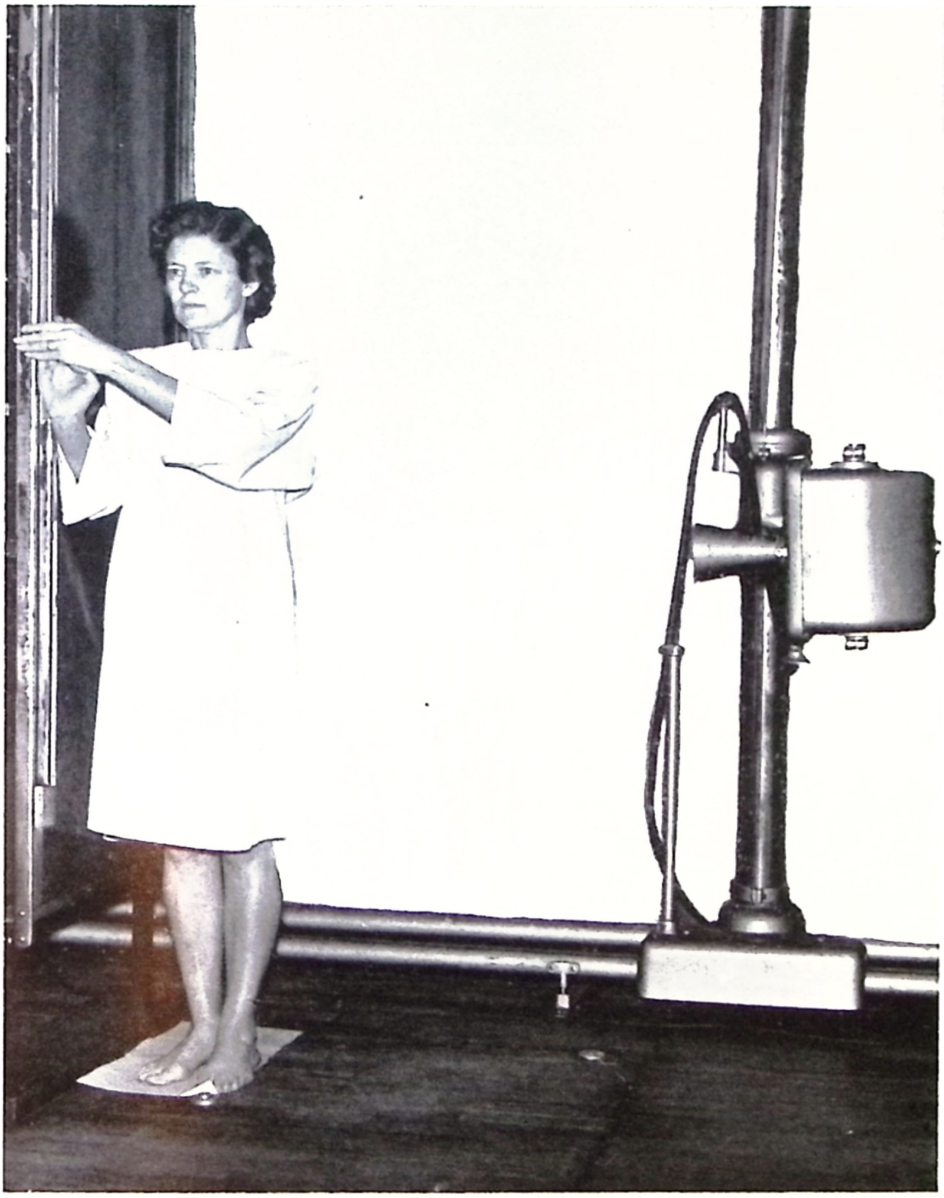


Figure No. 32

Full Spine—14x36—Lateral View Standing

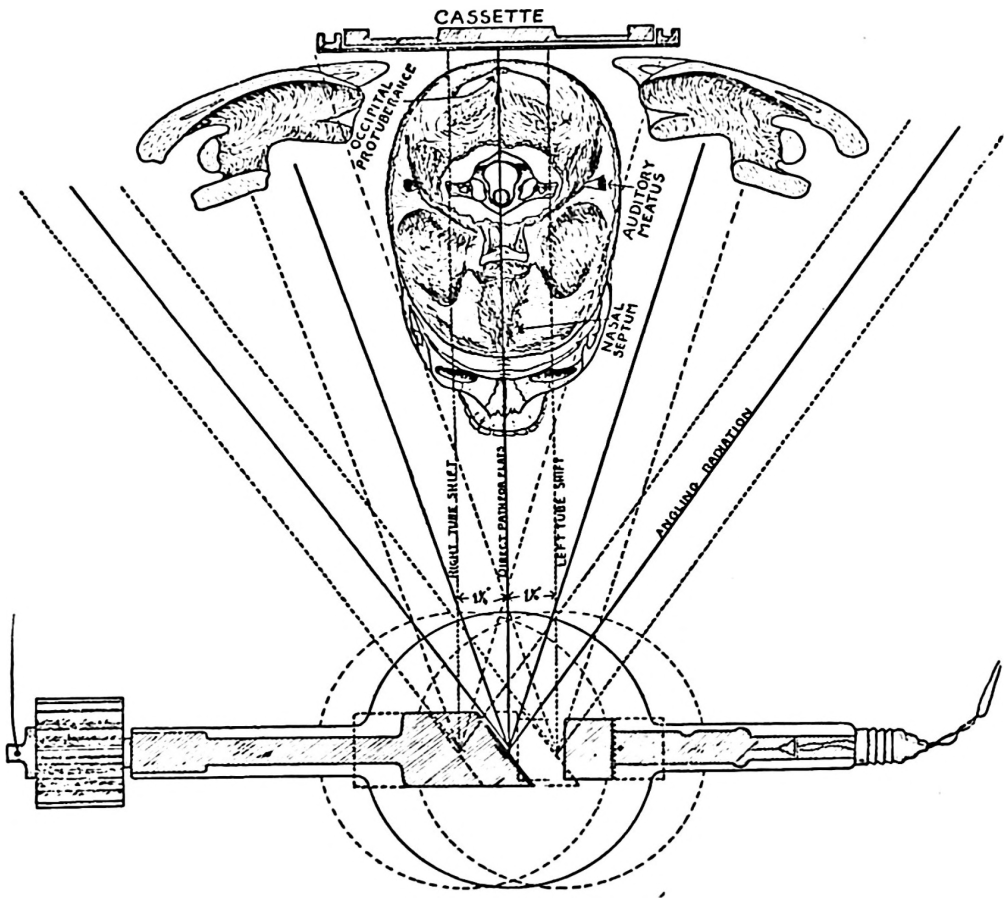


Figure No. 33

AP VIEW

Showing direct path of X-ray for A-P flat and stereo tube shifts

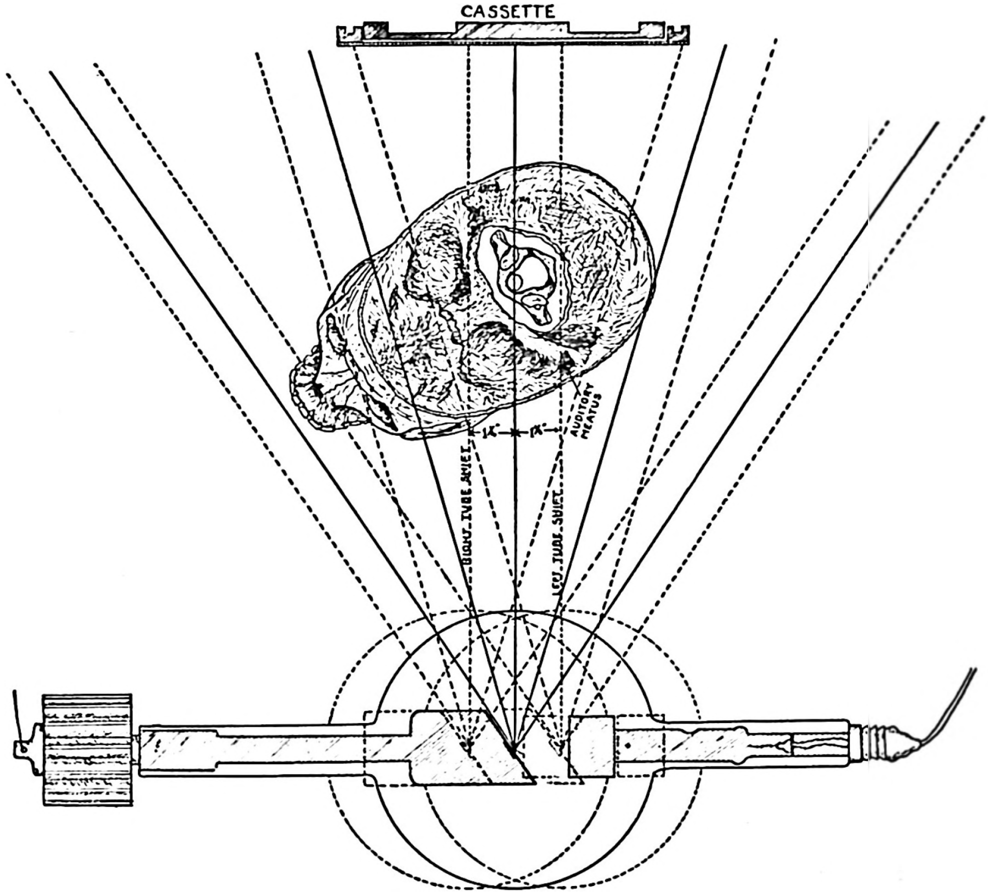


Figure No. 34

Showing course of direct rays in diagonal tube shift

CHAPTER 21

X-Ray Records

A well organized record system is indispensable. Identification of the film is made possible, along with technique remarks, case history and other information. This will eliminate embarrassment in retakes and also will enable the operator to produce better quality work.

When a case is referred to the laboratory, enter all data on a record card: date, a serial number, previous X-rays, accidents, and previous chiropractic care, region or regions to be exposed, posture and view, type of films, patient's weight cr thickness of part, technique (both machine and darkroom procedures), remarks, etc. If more than one person is actually doing the work, a technician's name should be added to the card.

Such records should be filed alphabetically, with a card for the name, number, and who referred the case in a separate card file. If only a small amount of X-ray work is done, the day book will be sufficient.

Though it is the custom of many laboratories to give the films out, it is not a good idea, and may cause some future difficulty. They should be a part of the doctor's records. A complete written report should always be sent to the doctor with suggestions, so far as X-rays are concerned.

The keeping of records as to machine technicalities and placement procedure is of material aid to the technician,

should he ever X-ray the patient again. The development of precision X-ray equipment makes possible comparative spinographic work. If a retake is needed at a later date to check on progress of the case in respect to the correction of mal-positioned vertebrae, etc., it can be correctly done. Where work is centered in the upper cervical region, it is almost impossible to do scientific work—and absolutely impossible to do comparative X-ray work—with only ordinary X-ray equipment, unless some sort of record is maintained.

Keeping records of the entire X-ray procedure is a most valuable aid in the production of better spinographs—those which are consistently accurate, both from analytical and definition standpoint.

CHAPTER 22

Spinographing Children

(1 month to 8 years)

It is usually difficult to get good readable upper cervical spinographs of children, in the upright position. They are nervous and invariably move. Then too, their double set of teeth obstruct so much it is almost impossible to arrive at the correct angle for the A to P view. There is no difficulty in taking the lateral view. Any attempt to force a child to sit—or particularly to lie—still, only aggravates and contracts muscles. This may increase or decrease rotation and, therefore, a true listing may not be obtained. However, if they will remain quiet during the exposure, readable spinographs can be made.

One of the first essentials when spinographing a child, or even a baby, is to win his confidence. Let him know you are not going to harm him. If necessary, show him the machine and tube—make him think you are playing with him. Get him interested; pretend it is a game. Much more will be accomplished this way than if you try to force him.

The writer is frequently asked if it is safe to spinograph babies; and how young can they be? We have spinographed a few one week old, and many two weeks old. To my knowledge there has never been injury; and this applies to pregnancy as well. Of course, we take all the precautions and

exposures are not made unnecessarily. The work is done instantaneously with 150 to 200 milliamperes. However, two things make baby procedures difficult. First, placement is seldom proper, and often some degree of motion appears on the film. Second, films usually are too dark. I believe the reason is mainly due to the equipment in the field not having sufficient capacity to make instantaneous exposures; therefore the added time.

To attempt to force a crying and excited baby into position is not a satisfactory method. The baby usually is not found in the center of the spinograph. This means placement and alignment were not correct; therefore distortion is increased. The twist and motion not only causes a blurring on the film, but produces muscular tension which may change vertebral alignment and interfere with correct analysis. When spinographing the cervicals, sometimes better results are attained if the mother holds the baby during the exposure. However, we usually suggest feeding the baby; then follow up with the exposure. This seems to get the best results; they lie relaxed; and often sleep. In this event spinographs are made more precisionally, with less possibility of error in the analysis.

The lateral and AP regular are the only two views which can be taken of babies with any degree of visibility in the cervical region. Stereos cannot be considered because of motion; nor the base posterior because of placement. So one may just as well save the time, effort and expense, because the latter views are seldom, if ever, satisfactory. The spinal column below axis should be made on a 14 x 17 rather than two 8 x 10 films. Although there is more superior and inferior distortion on the longer film, the smaller films usually reveal rotation and motion, and they never seem to match. In other words, the upper film of the two may reveal laterality and rotation in particular directions, while the lower film—because of the time in making the placement, etc.—will invariably show a discrepancy in the reading.

The question often arises as to the advantage of giving

the child an anaesthetic to relax it during the exposure. This is not considered advisable. The elements of risk are too great for any advantage gained.

The osseous structure of the child offers much less resistance than that of the adult; so extreme care must be taken when deciding the technique so as not to penetrate, but merely shadowgraph, the bony tissue to get clear outlines of the structures. It is advisable to use greater tube distance with sufficient KVP, etc., to make the exposure instantaneous. The increase in tube distance reduces distortion, secondary fog, and adds to definition.

Even though the X-ray equipment is grounded, some patients claim to feel the static. This will in no way have any ill effect. But it may cause them to move and reveal a blurriness on the film, making the spinograph practically useless. If retakes should then be necessary, increase the tube distance, if possible—which in turn increases the milliampere second limit. Also, higher milliamperes and fractional second of time will be an advantage.

Babies

Technique

Supine—stationary grid

Buck (red label) film—extra speed screens

1 to 6 months	MA	KVP	Time	Tube Dist.
Lateral cervical	150	62-68	1/10 sec.	36 inches
AP natural cervical	150	68-74	1/10 sec.	36 inches
Full Spine	150	60-64	1/10 sec.	36 inches
6 to 12 months				
Lateral cervical	150	68-72	1/10 sec.	36 inches
AP natural cervical	150	74-78	1/10 sec.	36 inches
Full spine	150	64-66	1/10 sec.	36 inches
1 yr. to 2 yrs.				
Lateral cervical	150	72-74	1/10 sec.	36 inches
AP natural cervical	150	78-80	1/10 sec.	36 inches
Full spine	150	66-68	1/10 sec.	36 inches
2 yrs. to 4 yrs.				
Lateral cervical	150	74-76	1/10 sec.	36 inches
AP natural cervical	150	80-82	1/10 sec.	36 inches
Full spine	150	68-74	1/10 sec.	36 inches

Children (4 to 8 years)

Technique

Upright position—bucky

Red label films—extra speed screens

	MA	KVP	Time	Tube Dist.
Lat. view	25	60	1 sec.	36 inches
AP view	25	70	1¼ sec.	36 inches
Lat. view	50	60	½ sec.	36 inches
AP view	50	70	¾ sec.	36 inches
Lat. view	100	60	1¼ sec.	60 inches
AP view	100	70	1¼ sec.	60 inches

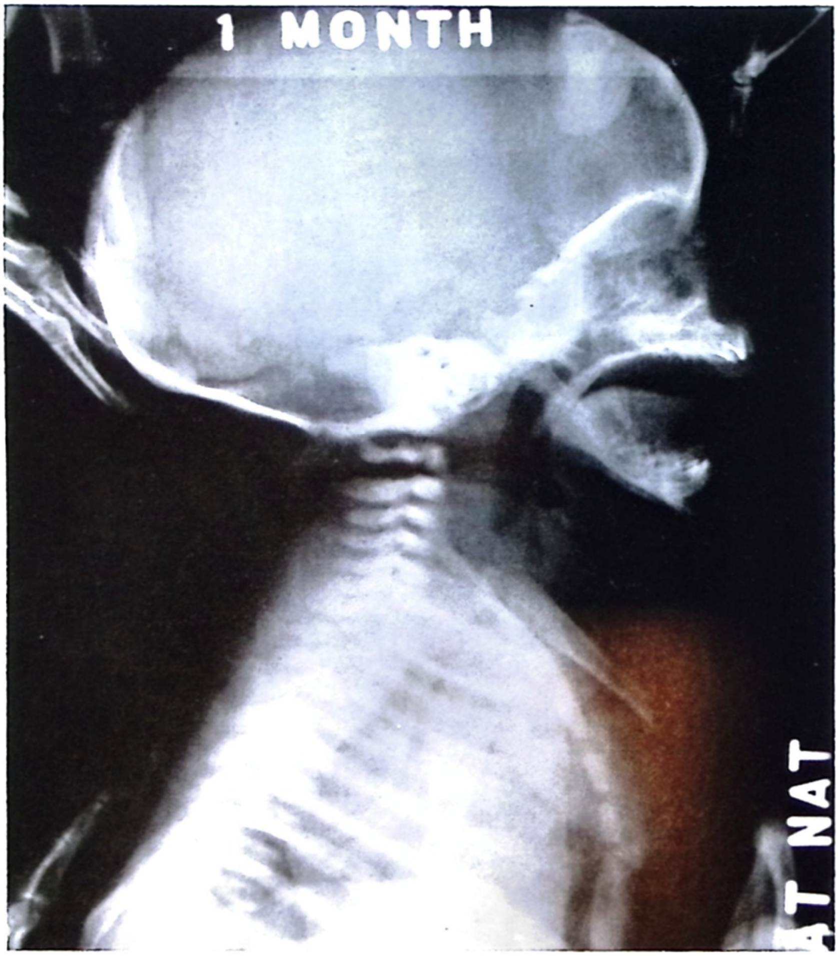


Figure No. 34a
Lateral Cervical (1 month)

Figure No. 34b

AP Cervical (1 month)

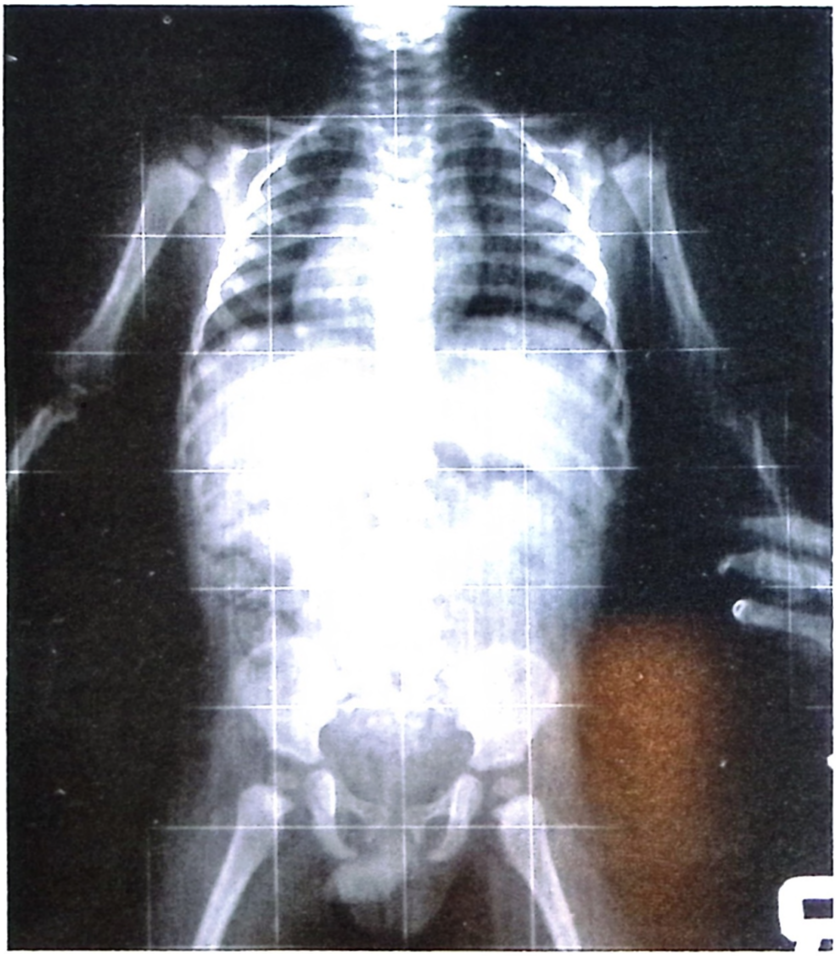


Figure No. 34c
Full Spine (6 months)

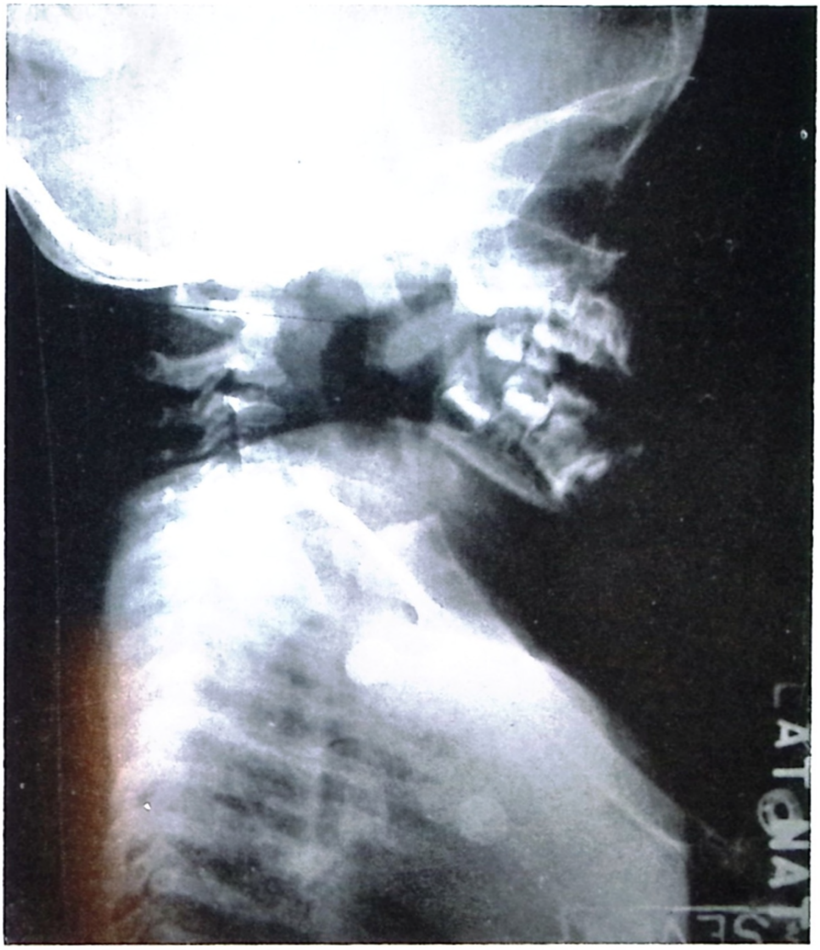


Figure No. 34d

Lateral Cervical (9 months)

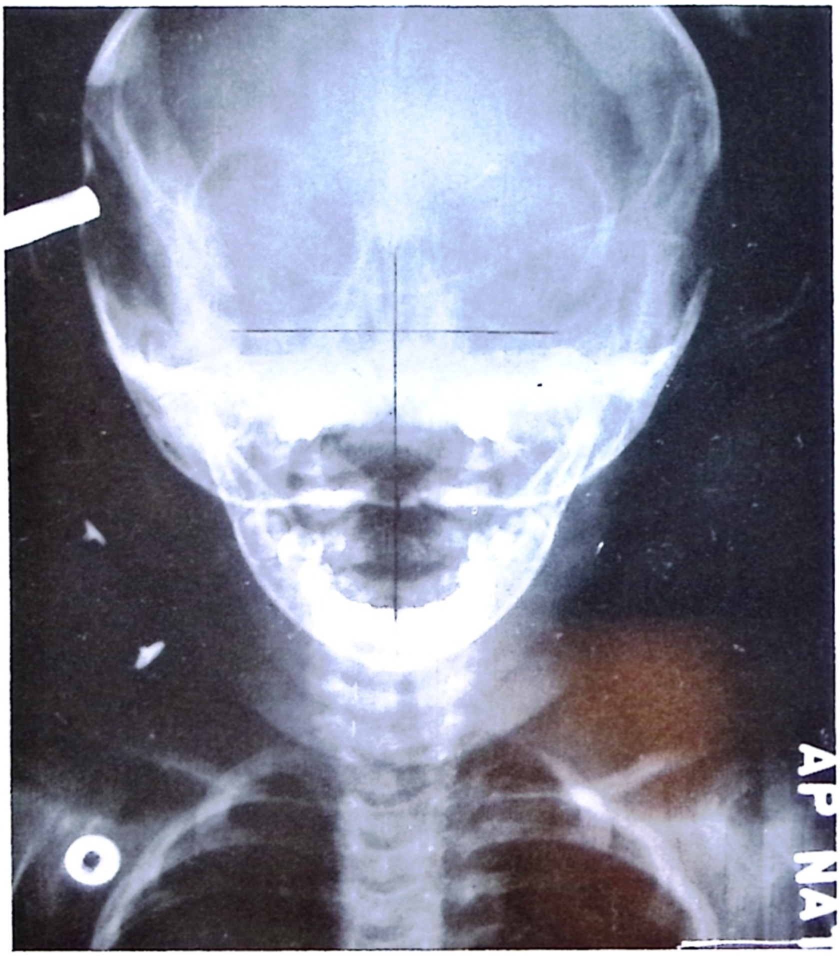


Figure No. 34e

AP Cervical (9 months)

Figure No. 34f

Lateral Cervical (14 months)

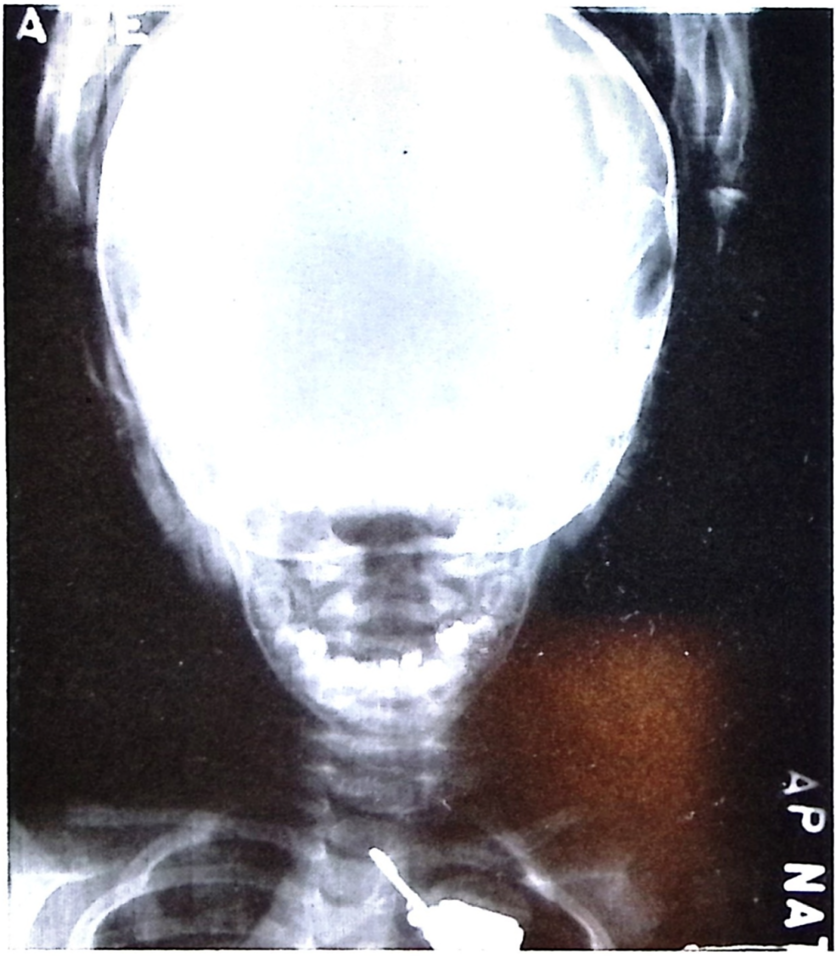


Figure No. 34g

AP Cervical (14 months)

CHAPTER 23

Generalities

New ideas, changes, and progress made in the manufacture of X-ray equipment and X-ray technique—at least insofar as machine technicalities are concerned—have passed through an evolutionary stage from its beginning to the present time. Each year in the past has brought about progress in improved technique. Undoubtedly, each year in the future will present something new, though the principle and theory of X-ray still remain as the discoverer found them.

Many factors enter into the making of an accurate readable diagnostic or analytical radiograph. Therefore, not knowing the variables existing within one's own laboratory or one's own community, the subject of technique is bound to be a very difficult subject to write about. However, the following details should be considered in any X-ray exposure procedure.

Are you aware that your automobile will operate more perfectly on a cloudy day than on a bright sunny day? Do you realize that electric currents have a greater, steadier value on such days: That is, its electrical peak may be greater and less variable on such days, due to the induction because of atmospheric conditions. Likewise, it is true that a better quality film is produced on a cloudy day than on a bright one. The writer is in no way intimating that you should wait for a cloudy day to make

your X-ray exposures; he just mentions this type of variable.

Some particular localities are more annoyed with variation in current than others. This may be due to an inferior set-up at the power plant itself, or to an overloading of equipment on the same line from the same pole transformer from which you draw your supply. For instance, ice machines, elevators, printing equipment, all interfere on an X-ray line circuit. Then too, a faulty tube, such as a gasseous one, will not permit a steady flow of current through the X-ray tube. The latter, of course, can be very readily rectified.

The characteristics of any X-ray tube play an important part in technique. A fractional difference in the width of the focal lines or a slight difference in the chemical analysis of the copper alloy of which the tube target is made are important variations. Further, there may be some difference in the durability of the tungsten button itself.

Intensifying screens are likewise important, for films are only as good as the screens make them. The amount and size of tungsten crystals within the screen's emulsion, the efficiency and the present condition of the binder which supports the tungsten crystals, perfect contact of screens and films, all promote film quality. Naturally, the best results are not obtained when film and screen contact is poor. If such is the case it is no doubt due to a twist in the cassette frame itself. Or there may be some indentation made within its face, or a variation in the thickness of the glue or adhesive necessary in adhering screens to the cassette frame.

A difference in the resistance of the bakelite and aluminum cassette faces may produce a slight variation in the quality of film, as the aluminum offers slightly more resistance than the bakelite. A given technique producing a fair quality film with a certain cassette and set of intensifying screens may be as much as 10 per cent inferior—or even more—compared to a film exposed in another cassette with another set of intensifying screens.

X-ray machines are not constructed identically in their graduations, so one may operate different from another. Physical conditions enter into the making of a good picture. For instance, fluid in dropsical conditions makes it difficult to produce readable films; painter's colic or lead poisoning in the system offers more resistance to the X-ray, naturally interfering when such exposures are made. Then of course, there is a difference in the exposure of the growing up and the adult individual—particularly so of older patients, even though they may be of the same weight, height and thickness. Films made of elderly people are never as contrasty and clearly outlined as those of the younger individual because the films are usually overexposed.

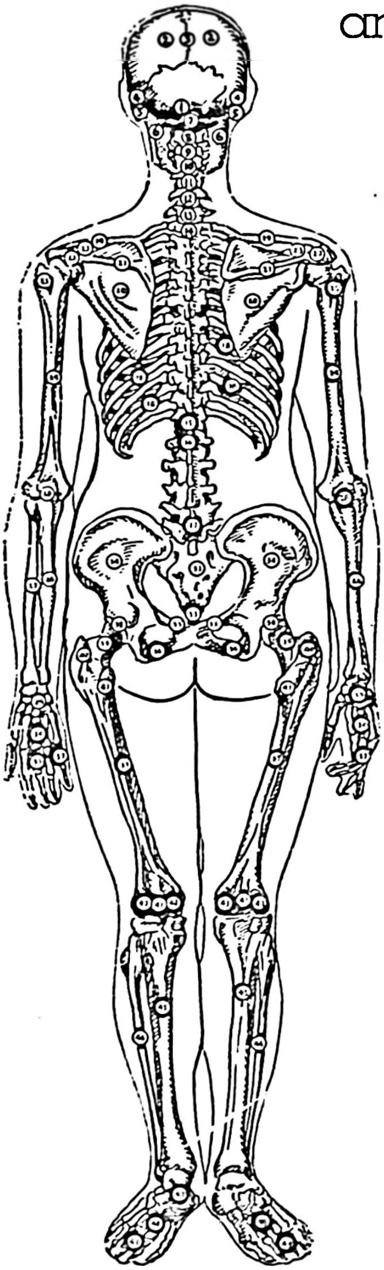
The writer also believes that better results in film developing may be obtained if one uses the developer made by the manufacturer from whom he purchased his films. Without a doubt, developing ingredients, amounts, etc., are made to develop a certain particular film emulsion.

Finally, the writer wishes to point out that the technique outlined in this text has been worked out in the laboratories of the Palmer School of Chiropractic, it has been tested, and has produced good quality films (such as seen in the following cuts) with our own equipment and accessories. Though it may not work to your satisfaction, it will at least give you a good firm foundation on which you may build your own technique. For having made a single picture from the proposed technique, you will readily know what to do in making the second one if another is necessary.

The following two skeleton cuts, anterior to posterior and posterior to anterior, will be of some assistance in the study of this work.

CHAPTER 24

Skeleton, Placements, Radiographs and Techniques



Posterior View

1 Occipital Bone
2 Parietal Bones
3 Sutures
4 Temporal Bones
5 Mastoid Process of Temporal Bones
6 Inferior Maxilla
7 1st } atlas
8 2nd } axis
9 3rd
10 4th } Vertebrae of the Neck
11 5th
12 6th
13 7th
14 1st Dorsal Vertebra
15 12th Dorsal Vertebra
16 1st Lumbar Vertebra
17 5th Lumbar Vertebra
18 Ribs
19 Clavicle
20 Scapula
21 Spine of Scapula
22 Acromion Process of Scapula
23 Coracoid Process of Scapula
24 Humerus
25 Great Tuberosity of Humerus
26 Ulna
27 Radius
28 Olecranon Process of (?)
29 Carpus
30 Metacarpus
31 Phalanges
32 Sacrum
33 Coccyx
34 Ilium
35 Pubis } Of Hip Bone
36 Ischium
37 Shaft of Femur
38 Head of Femur
39 Neck of Femur
40 Great Trochanter of Femur
41 Small Trochanter of Femur
42 Outer Tuberosity of Femur
43 Inner Tuberosity of Femur
44 Inter Condylar Notch of Femur
45 Tibia
46 Fibula
47 Os Calcis
48 Metatarsus
49 Phalanges

Figure No. 35
Skeleton (Rear View)

Anterior View

1 Frontal Bone
2 Parietal Bones
3 Temporal Bone
4 Malar Bones
5 Bony Orbit
6 Superior Maxilla
7 Bony Cavity of Nose
8 Vomer
9 Teeth
10 Inferior Maxilla
11 5th Cervical Vertebra
12 6th Cervical Vertebra
13 7th Cervical Vertebra
14 1st Dorsal Vertebra
15 Manubrium, or Handle of Sternum
16 Body of the Sternum
17 Ensiform Process
18 Clavicle
19 Scapula
20 Coracoid Process of Scapula
21 1st
22 2nd
23 3rd
24 4th } True Ribs
25 5th
26 6th
27 7th
28 8th
29 9th
30 10th } False Ribs
31 11th
32 12th
33 Costal Cartilage
34 12th Dorsal Vertebra
35 1st Lumbar Vertebra
36 2nd Lumbar Vertebra
37 3rd Lumbar Vertebra
38 4th Lumbar Vertebra
39 5th Lumbar Vertebra
40 Sacrum
41 Ilium
42 Crest of Ilium
43 Crest of Pubis
44 Ischium
45 Thyroid, or Obturator Foramen, round opening of Os-Innominatum
46 Humerus
47 Lower Head of Humerus
48 Ulna
49 Radius
50 Carpus
51 Metacarpus
52 Phalanges
53 Shaft of Femur
54 Upper Head of Femur
55 Neck of Femur
56 Great Trochanter of Femur
57 Lesser Trochanter of Femur
58 Outer Tuberosity
59 Inner Tuberosity
60 Patella
61 Tibia
62 Fibula
63 Inner Malleolus (of the Tibia)
64 Outer Malleolus (of the Fibula)
65 Tarsus
66 Metatarsus
67 Phalanges

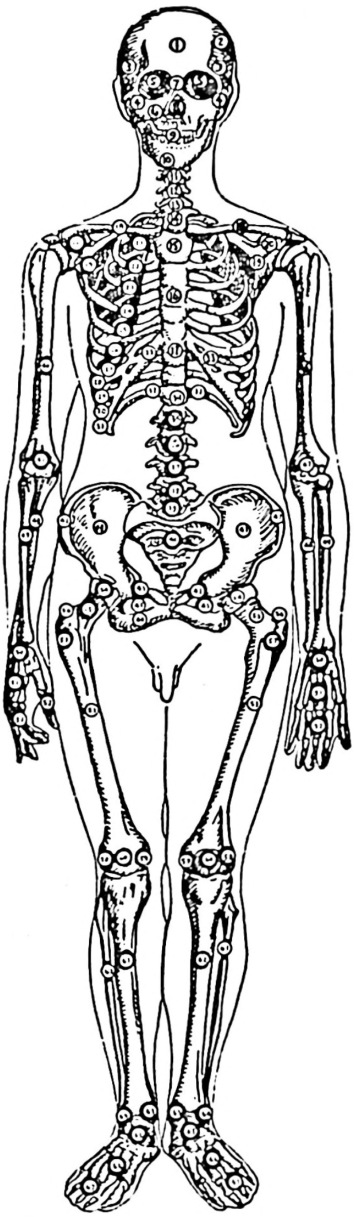


Figure No. 36
Skeleton (Front View)

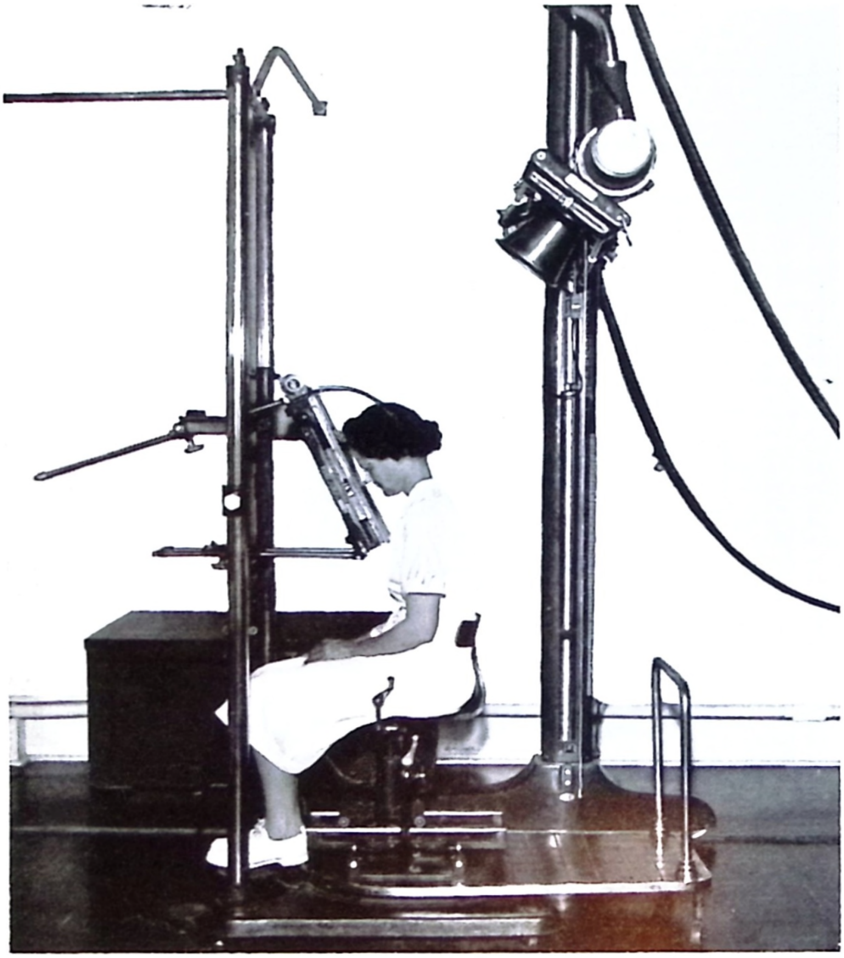


Figure No. 37

FRONTAL SINUSES — PA View

Film—8x10 film is placed lengthwise to patient's head.
Preparation—none necessary.
Posture—In either the upright or prone position with the forehead or nose touching the bucky or cassette. Always put the bridge of the nose in the center of the cassette. Immobilizing apparatus should be used to prevent movement.
Tube Position—The central rays should be directed toward the center of the cassette, penetrating the skull just above the floor of the cranial cavity.
Description of the film—The negative reveals an unobstructed view of the contour of the sinus walls and the upper half of the orbital cavity. A portion of the antrum is obstructed somewhat by the shadow of the petrous portion of the temporal bone.

Figure No. 37a

FRONTAL SINUSES — PA View

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	75	2¼ sec.	36″
100	68	1 sec.	36″

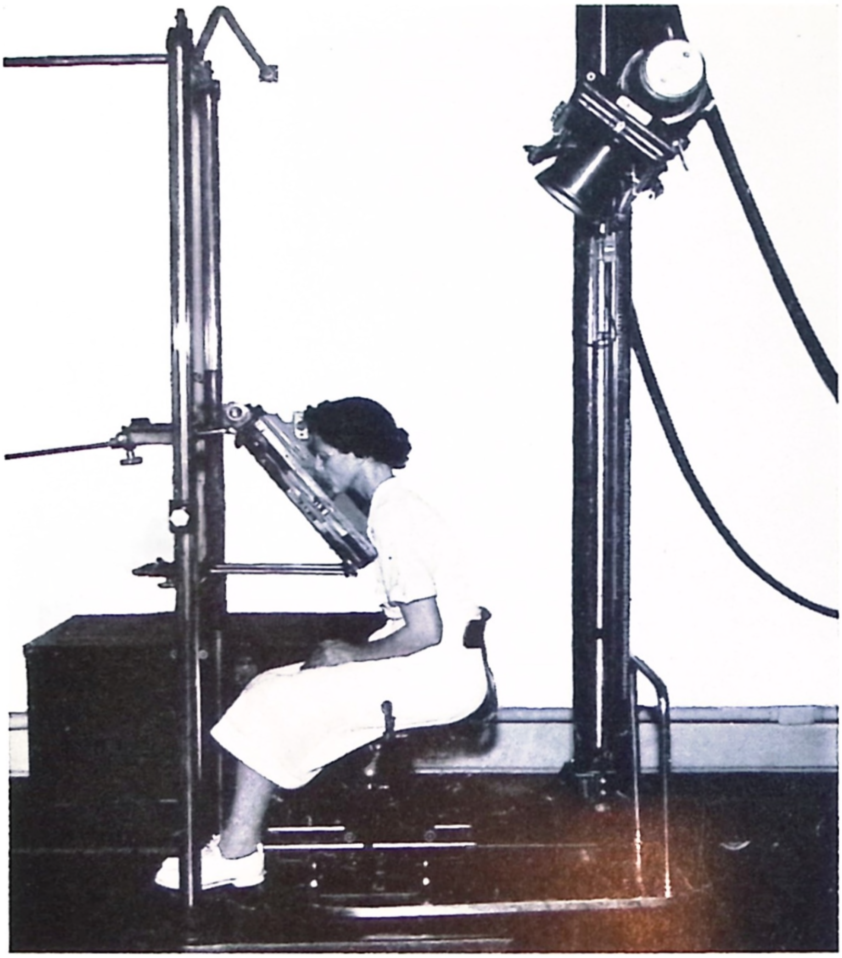


Figure No. 38

MAXILLARY SINUSES — PA View

Film—Usually an 8x10 film is used, placed lengthwise to the patient's head.

Preparation—None necessary.

Posture—Either upright or prone, with chin and nose touching bucky or cassette, the tip of the nose approximately in the center of the film, head immobilized.

Tube position—Central rays directed to the center of the cassette. The rays will come just superior to the cranial floor, missing the heavy bones of the skull.

Description of the film—The negative reveals the contour of the frontal sinus walls, septa, complete orbital walls, and antrum and maxillary sinus walls. The shadow of the petrous portion of the temporal bone falls below the antrum.

Figure No. 38a

MAXILLARY SINUSES — PA View

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	75	2¼ sec.	36″
100	68	1 sec.	36″

Figure No. 39

MASTOID PROCESS — Patient Prone

Film—Usually an 8x10 is used, placed lengthwise to the patient's head.

Preparation—None necessary.

Posture—Patient in either upright sitting or prone position, patient's face turned allowing the nose and the side of the face to be against the cassette or bucky, the mastoid in question about in the center of the cassette, with the pinna of the ear turned forward.

Tube position—Center the tube so that the central rays are directed at the center of the cassette or film, striking the head obliquely from the superior.

Description of the film—Reveals the auditory canal and the contour of the mastoid cells with their dividing walls.

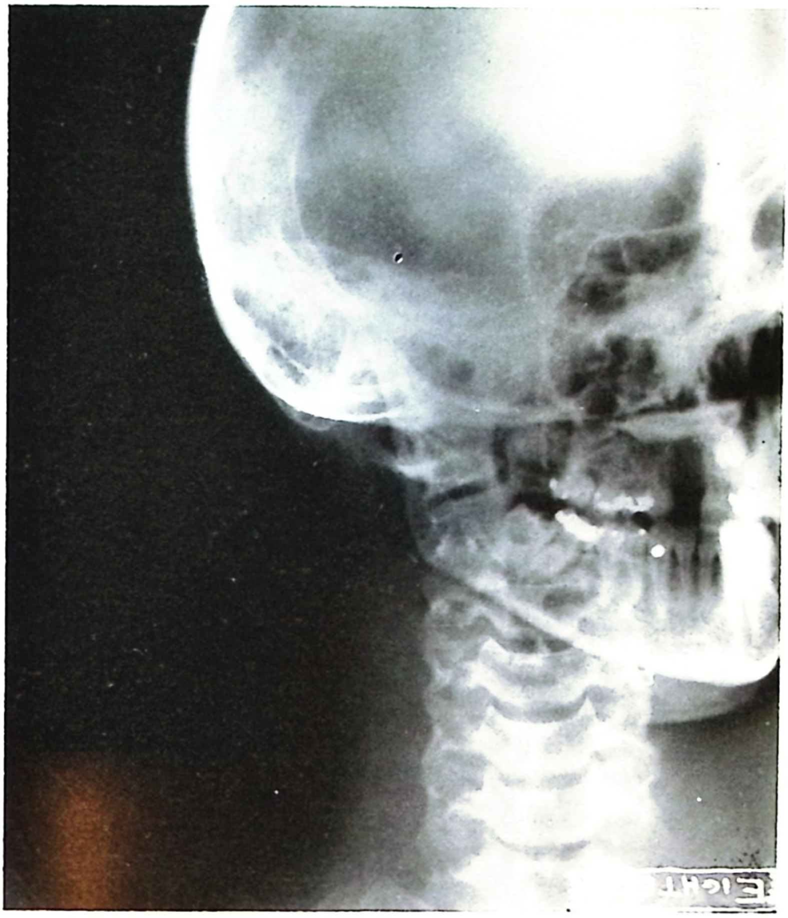


Figure No. 39a

MASTOID PROCESS — Patient Prone

Technique

Extra Speed Screens

Buck (Red Label) Film

Without Bucky

M.A.	KVP	Time	Tube Dist.
25	50	2 sec.	30″
100	50	7/10 sec.	30″

Figure No. 40

MANDIBLE — Patient Prone

Film—8x10 placed lengthwise to the patient's head.

Preparation—None necessary.

Posture—Either reclining or upright; upright posture advisable. The jaw to be taken should be placed next to the cassette, patient's chin elevated from the chest, resting as far up on the cassette as the position of the cassette against the shoulder will permit. The jaws should lie in a parallel plane to the cassette, center of the jaw placed horizontally at the center of the cassette.

Tube position—Placed so that the central rays will strike the mid-region of the jaw and the center of the cassette at about a 10° angle.

Description of the film—Reveals contour of most of lower jaw, including route-canals and contour of both upper and lower molars and cuspids.

Figure No. 40a

MANDIBLE — Patient Prone

Technique

Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	55	¾ sec.	30″
100	55	2/10 sec.	30″

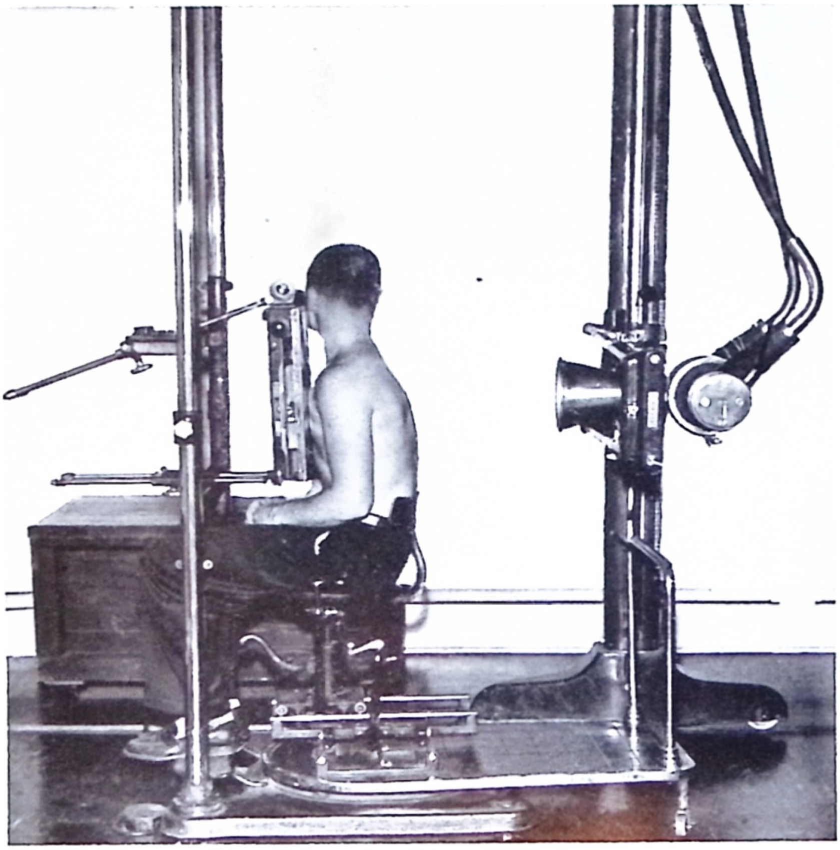


Figure No. 41

CLAVICLE — PA View

Film—If for fracture, 8x10, placed lengthwise with patient's body; if for any other purpose, a 14x17 is advisable to make possible comparative studies.

Preparation—Clothing removed from the area to be X-rayed.

Posture—If using an 8x10 film, either the supine or upright position is used. The patient is placed, facing the cassette, with the head turned away from the clavicle to be X-rayed, and placed against the bucky or cassette so that both extremities will show on the film. If using a 14x17 film, either the prone or upright position may be used, preferably the upright; the patient facing the cassette or bucky, with the episternal notch in the center, vertically. Both arms should be in the same position.

Tube position—Central rays directed at the episternal notch perpendicularly to the cassette.

Description of the film—Reveals contour of clavicle, its articulation at the sternum and its articulation with the acromion process of the scapula.

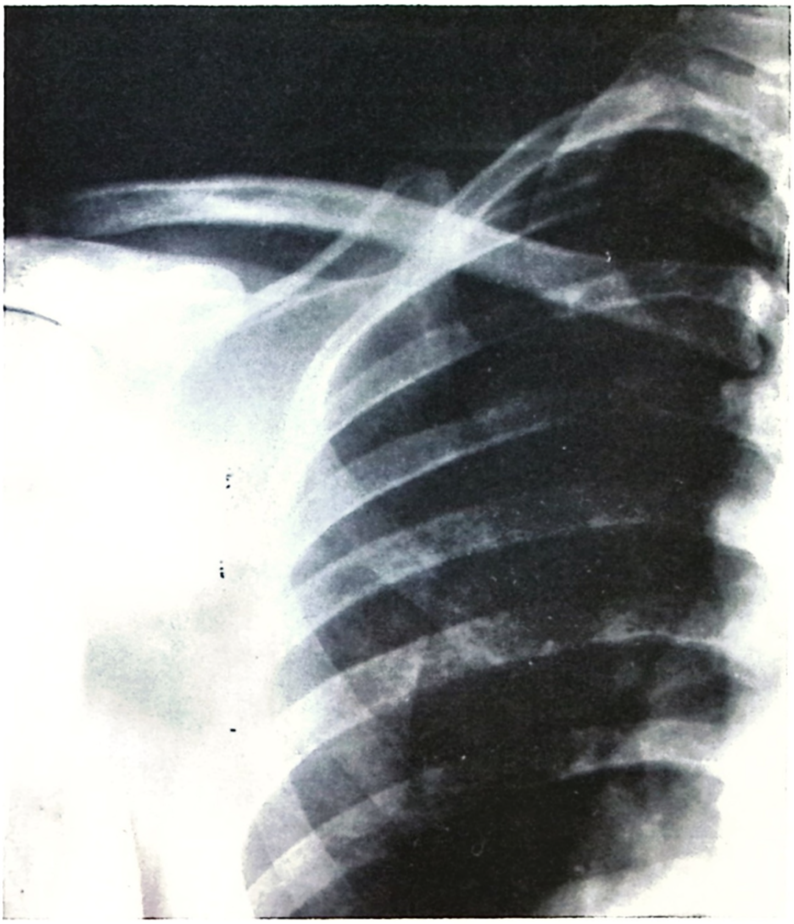


Figure No. 41a

CLAVICLE -- PA View

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	53	2½ sec.	36″
100	60	¾ sec.	60″

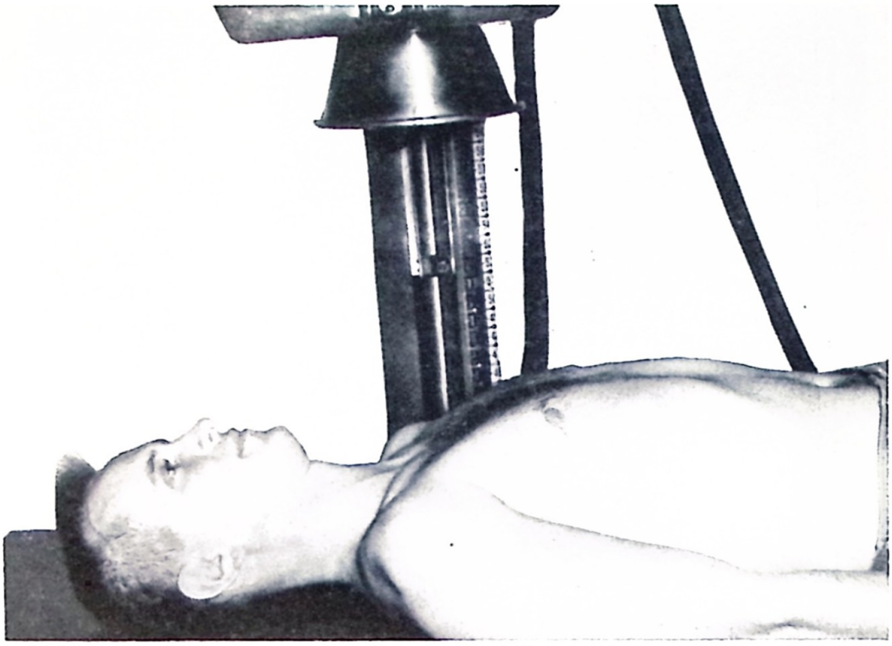


Figure No. 42

SHOULDERS — AP View

In radiographing the shoulder joint, several points must be considered—the most important being the purpose. In fractures, an 8x10 film may be used. The patient is in either an upright sitting or a supine posture, placed so that the head of the humerus will appear in the center of the film. The tube is placed so that the central rays are directed perpendicularly to the center of the film or cassette, thereby centering the rays on the head of the humerus. When the patient is in either the sitting or supine posture, the arm and forearm are at the side with the palmar surface of the hand facing forward.

Occasionally, where the coracoid process is fractured or where other angles are necessary, a P to A or oblique view may be of value.

In almost any type of fracture a stereoscopic view will give a much greater amount of information. An incomplete epiphysial fracture may be difficult to specifically locate as to degree of depth, etc. The third dimension views make this possible. Suggest using a 60" tube distance with the corresponding 2½-inch horizontal tube shift, 1¼ inches either side of the median line.

When looking for conditions other than fractures, a film large enough to include both shoulders is recommended, preferably a 14x17.

So often in X-raying just one shoulder and attempting to determine irregularities, malformations, etc., there is a possibility of the anomalies being congenital in nature and a question as to it having any bearing upon the incoordination existing. In taking both shoulders, one can make a comparison and usually arrive at an accurate conclusion. When taking both shoulders, either stereoscopically or naturally, the film is placed about 2 inches above the superior border of the shoulder, with the tube centered over the episternal notch, using a 48-inch tube distance with the necessary horizontal tube shift of 4 inches—2 inches on both sides of the median line. The arms should be at the patient's side, with forearms over and across the abdomen.

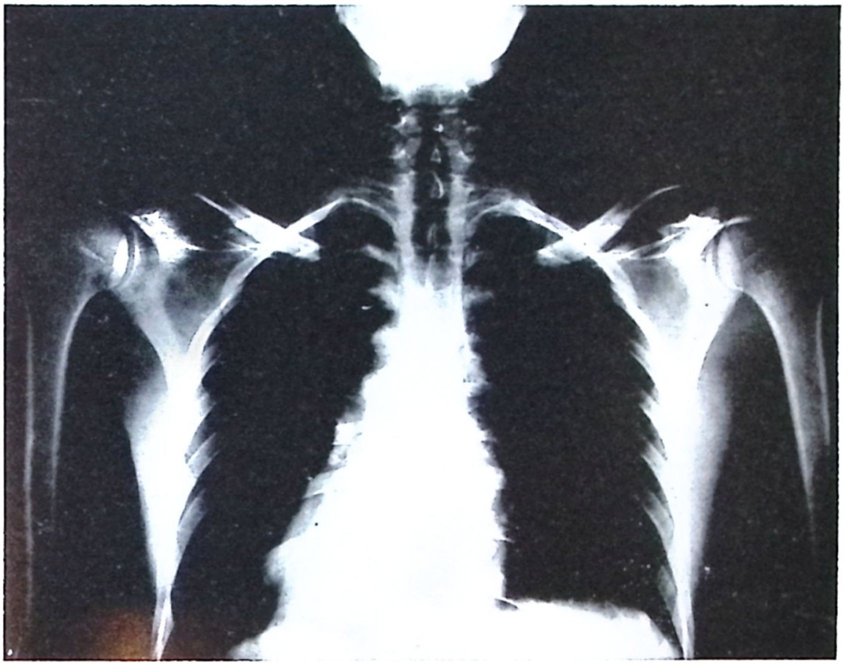


Figure No. 42a

SHOULDERS — AP View

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	65	3 sec.	36″
100	60	1 sec.	60″

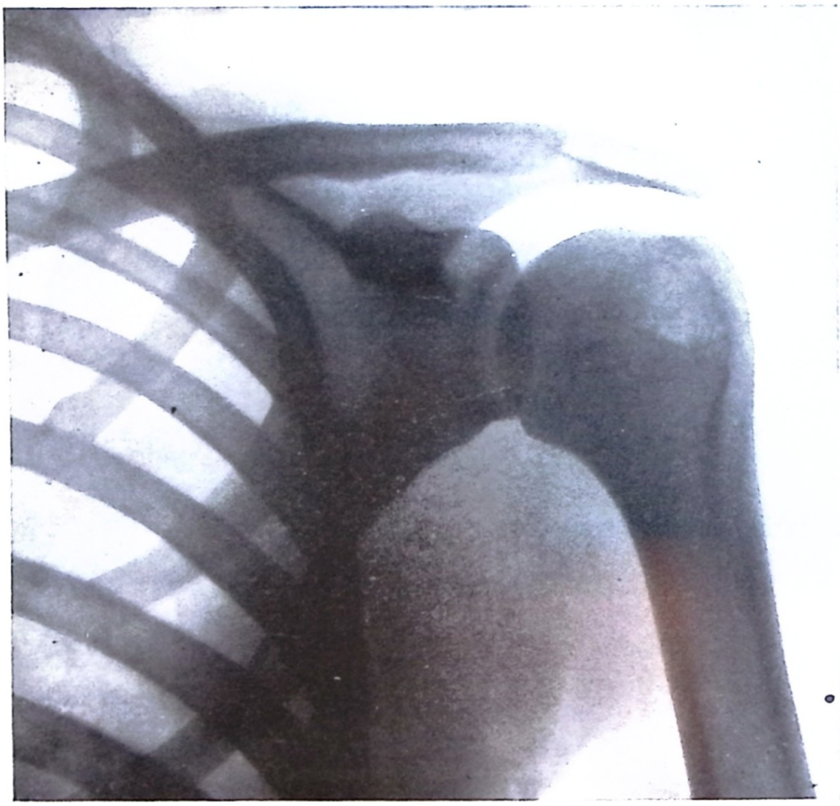


Figure No. 43

SHOULDER — PA View

SHOULDER — PA View

Film—Usually an 8x10, unless a comparison is to be made—then use a 14x17.

Preparation—Clothing removed from area to be X-rayed.

Posture—Either prone or upright, patient placed so that the shoulder will appear in the upper and outer one-third of the film. The patient's face is turned away from the shoulder to be X-rayed, arms at side, and palmar surface of the hand facing inward. The patient must not breathe during the exposure. If both shoulders are to be shown, a 14x17 film is used. Place the cassette so that the episternal notch appears in the center, and so the top of the film comes about even with the 5th cervical vertebra.

Tube position—Central rays directed at the head of the humerus and at right angles to the cassette or bucky. If both shoulders are X-rayed, center rays at the episternal notch.

Description of the film—Shows contour of the outer half of the clavicle, head of the humerus, epiphysial lines in some cases and epiphysial separations in young individuals, contour of upper part of the shaft of the humerus and, somewhat, that of the glenoid fossa.

SHOULDER

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	65	3 sec.	36″
100	60	1 sec.	60″

Figure No. 44

ELBOW — Lateral View

Film—8x10.
Preparation—None necessary.
Posture—The patient should be in the sitting upright position. The arm and forearm are placed on the cassette rack with the palmar surface of the hand down, while the forearm is slightly inducted.
Tube position—Central rays directed at the elbow, perpendicularly to the cassette.
Description of the film—The inferior portion of the humerus shows quite distinctly in its articulation in the semilunar notch. The articulating surface at the head of the radius, with the humerus and the radial notch of the ulna, shows the contours of the olecranon process and the radial notch.

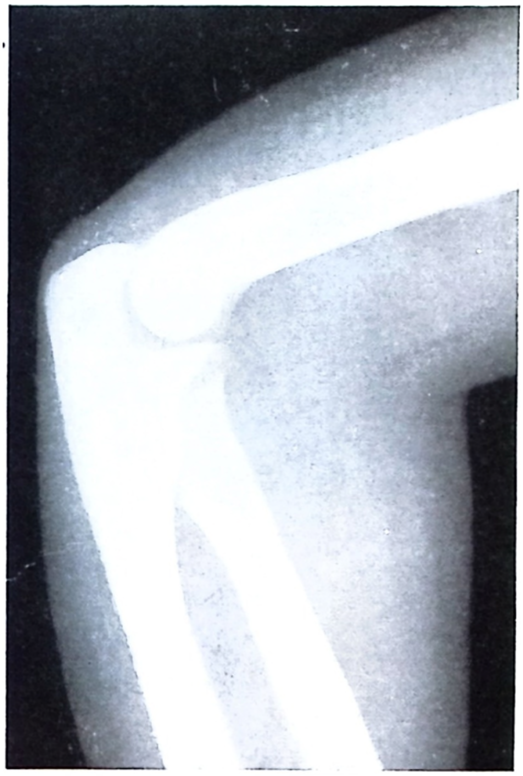


Figure No. 44a

ELBOW — Lateral View

Technique

Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	58	½ sec.	36″
100	48	3/10 sec.	36″

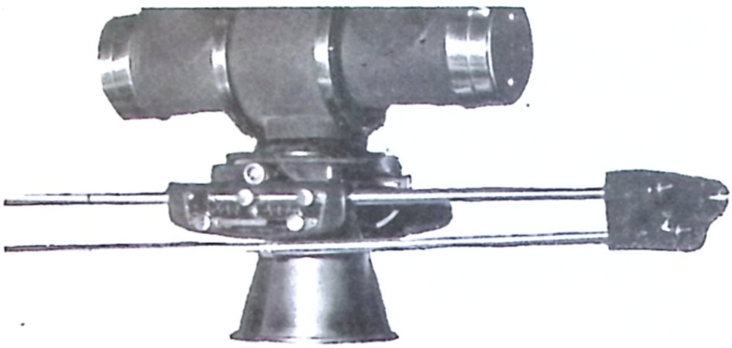


Figure No. 45

ELBOW — AP View

Film—8x10.

Preparation—None necessary.

Posture—The arm is extended flat on the cassette, with the palmar surface of the hand up. Sand bags are used to hold the forearm and arm motionless. The elbow should be in the center of the cassette.

Tube position—The tube is placed so that the central rays will strike the elbow at right angles to the cassette. A lead cone may be used to bring out more detail.

Stereoscopic views of the elbow joint facilitates specific interpretation. A 30-inch tube distance is used, with the necessary horizontal tube shift. Stereoscopic views more distinctly abbreviate the true contour of all three dimensions.

Description of film—Revealing the true contour of all three dimensions showing the relative position of the articular surfaces of the superior extremity of the radius and ulna, including the radial notch, olecranon process, corocoid process, etc., showing the inferior articulating surfaces and depressions of the humerus, also making possible true conception of the size of the space between the articulating surfaces.

Figure No. 45a

ELBOW — AP View

Technique

Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	55	½ sec.	36″
100	46	3/10 sec.	36″

Figure No. 46

HAND AND WRIST — PA View

Film—8x10.

Preparation—None necessary.

Posture—The palmar surface of the hand should be down, the fingers outstretched and spread slightly so there will be less overlapping of the osseous structures, especially at the carpal end of the phalanges.

Tube position—The rays should be directed over the center of the palm.

Description of film—Complete contour of the carpals, metacarpals and phalanges, soft structure contours and articular spaces. Minute cancellous structure of metacarpal and phalangeal epiphyses. Epiphysial separations in children; sesamoid bones in the adult.

Figure No. 46a

HAND AND WRIST — PA View

Technique

With Cardboard Exposure Holder

Buck (Red Label) Film

Without Bucky

M.A.	KVP	Time	Tube Dist.
25	50	3 sec.	36″
100	40	2 sec.	36″

Figure No. 47

HAND AND WRIST — Diagonal View

Film—8x10 placed lengthwise with the hand.

Preparation—None necessary.

Posture—Patient's arm somewhat out-stretched, palmar surface of the hand down, with surface nearest little finger resting on cassette; palmar surface nearest thumb raised, tips of fingers spread and resting on the cassette.

Tube position—Rays directed at the center of the hand, perpendicularly to the cassette.

Description of the film—Reveals phalangeal spaces and somewhat of the metacarpal and phalangeal articulations, complete contours of the phalanges and, to a certain extent, the carpals, the epiphysial separations in children and sesamoid bones in adults.

Figure No. 47a

HAND AND WRIST — Diagonal View

Technique

With Cardboard Exposure Holder
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	50	3 sec.	36″
100	38	2 sec.	36″

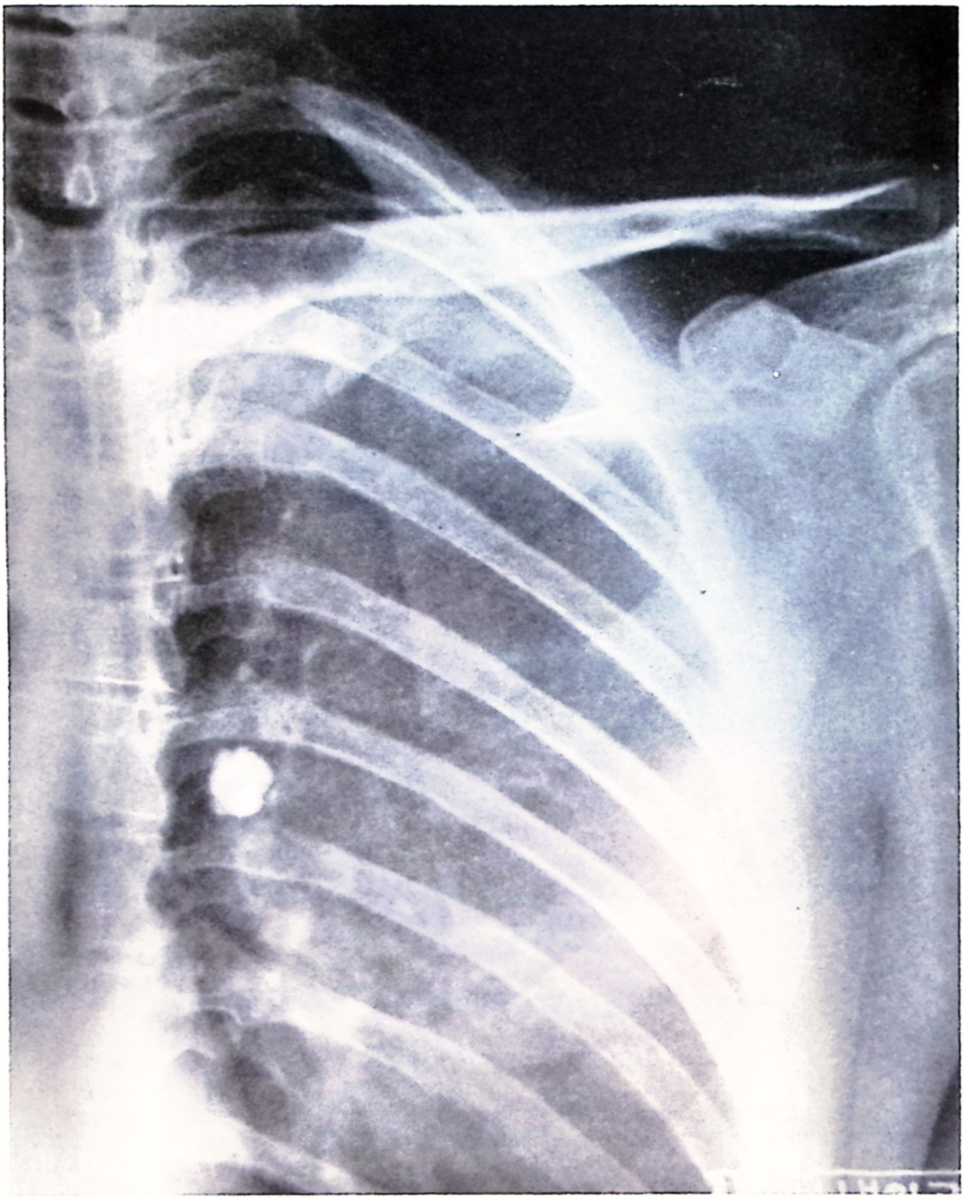


Figure No. 48
Scapula—AP View

SCAPULA — AP View

Film—Usually an 8x10 film is used.

Preparation—Clothing over that area removed.

Posture—Either upright or supine, patient placed so that the shoulder appears at the outer and upper part of the film. The patient must not breathe during the exposure.

Tube position—Tube placed so that rays will strike about 2 inches in from head of the humerous, perpendicularly to the cassette.

Description of the film—Reveals contours of its acromion process, spine of the scapula, coracoid process, glenoid fossa, and the angles and borders.

SCAPULA — AP View

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	64	1½ sec.	36″
100	60	1 sec.	60″

Figure No. 49

STERNUM — PA Diagonal View

Film—8x10.

Preparation—A cotton gown is substituted for the patient's clothing.

Posture—The patient should be in either the prone or upright posture, with the ventral surface of the thorax against the cassette. Place the superior edge of the film about 1¼ inch above the episternal notch.

Tube position—The tube is shifted to one side or the other of the median line of the cassette or bucky, 8 to 10 centimeters, so that the direct rays will pass beside the spinal column to the center of the sternum.

Description of film—Complete contour of the three parts of the sternum. The articulation of manubrium or top section of sternum with clavicle. The junction of the manubrium with the body of the sternum or gladiolus and the ensiform cartilage or xyphoid process. Contours of facets for articulation with cartilage of the first seven pairs of ribs.

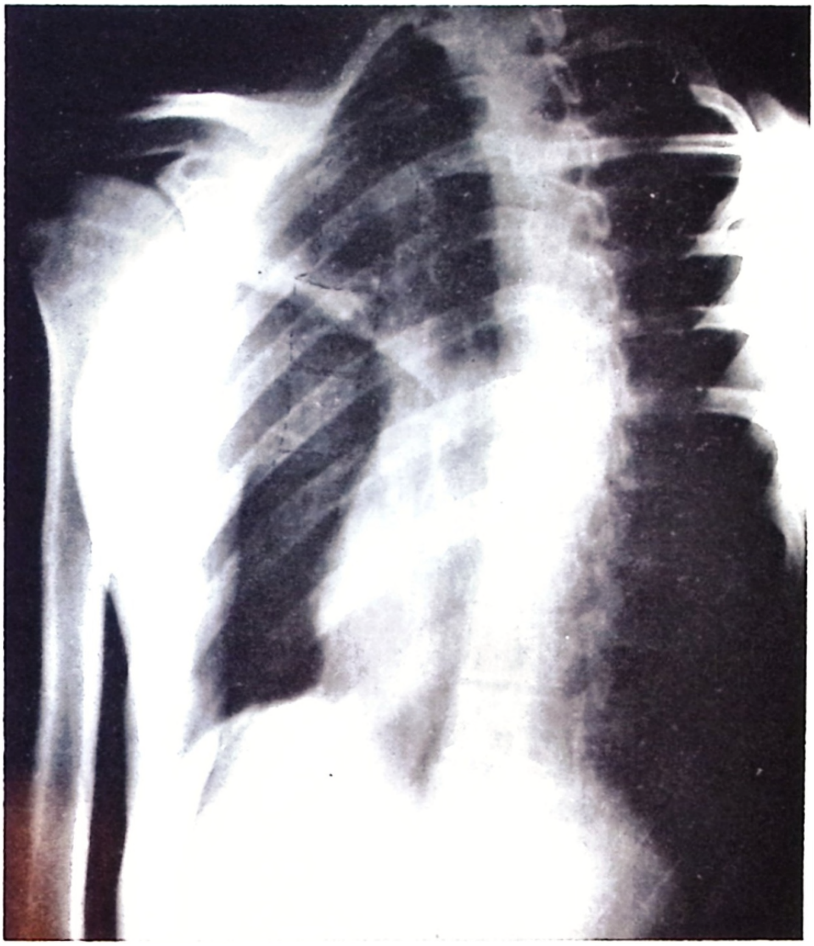


Figure No. 49a

STERNUM — PA Diagonal View

Technique

Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	60	2 sec.	30″
100	64	6/10 sec.	60″

Figure No. 50

LATERAL STERNUM

Film—Usually an 8x10.

Preparation—Clothing over that area removed and a cotton gown substituted.

Posture—Patient's side next to the cassette, with the arms forced back or extended above the head. If patient is lying on the side, compression bands are used. The top of the cassette should come about 1 inch above the episternal notch. The patient must not breathe during the exposure.

Tube position—Central rays directed perpendicularly to the cassette at the mid-region of the sternum.

Description of film—Lateral view of sternum always superimposed by costal cartilages and, somewhat, by the chondral ends of the ribs. Revealing the three parts of the sternum: namely, the manubrium, gladiolus and ensiform cartilage.

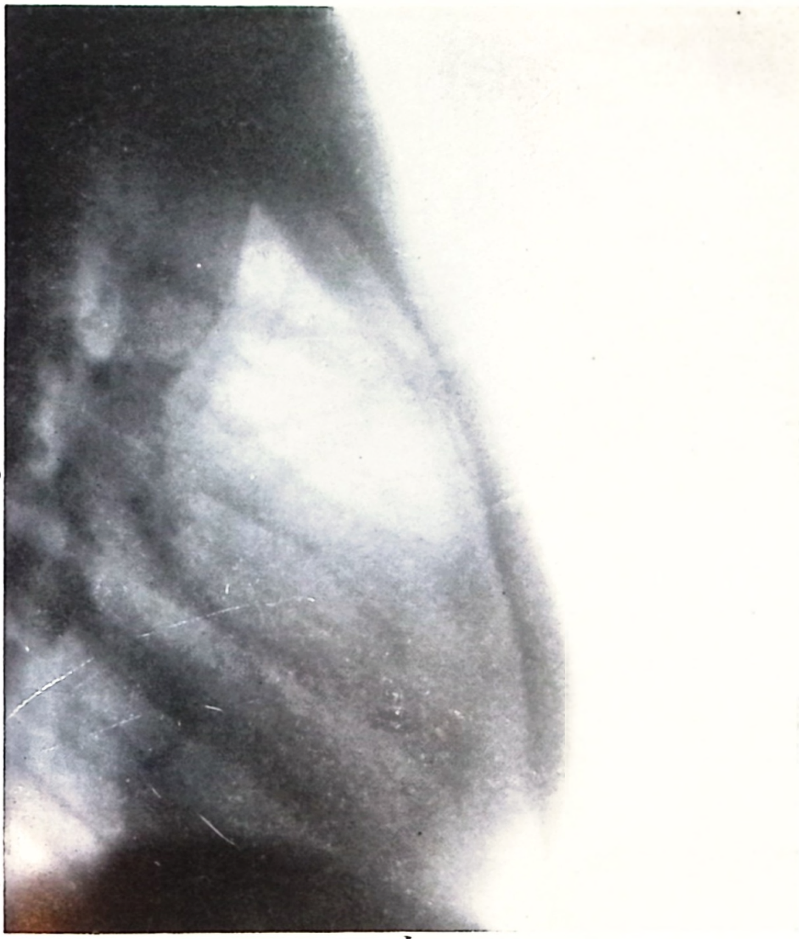


Figure No. 50a

STERNUM — Lateral View

Technique

Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
24	65	2 sec.	30″
100	66	8/10 sec.	60″

Figure No. 51

CHEST — PA View

Film—14x17.

Preparation—Clothing removed to the waist.

Posture—Either sitting or standing, the patient faces the cassette, has his hands on his hips or held at the back, with the elbows forward, so as to pull the scapulae toward the side. The cassette is placed so that the top of the film will be even with about the fifth cervical. The patient should inhale and hold breath during the exposure.

Tube position—Placed so that the central rays are directed at about the sixth dorsal, perpendicularly to the cassette.

Description of chest—PA View—Complete contour of both lungs, including the base of the lungs as well as the apices. The outline of the heart, the upper part of the diaphragm and the spine, the latter as a white shaft in a film properly made.

Contour of the hilus of the lung, the branching of the bronchi and some of the larger vessels should be seen.

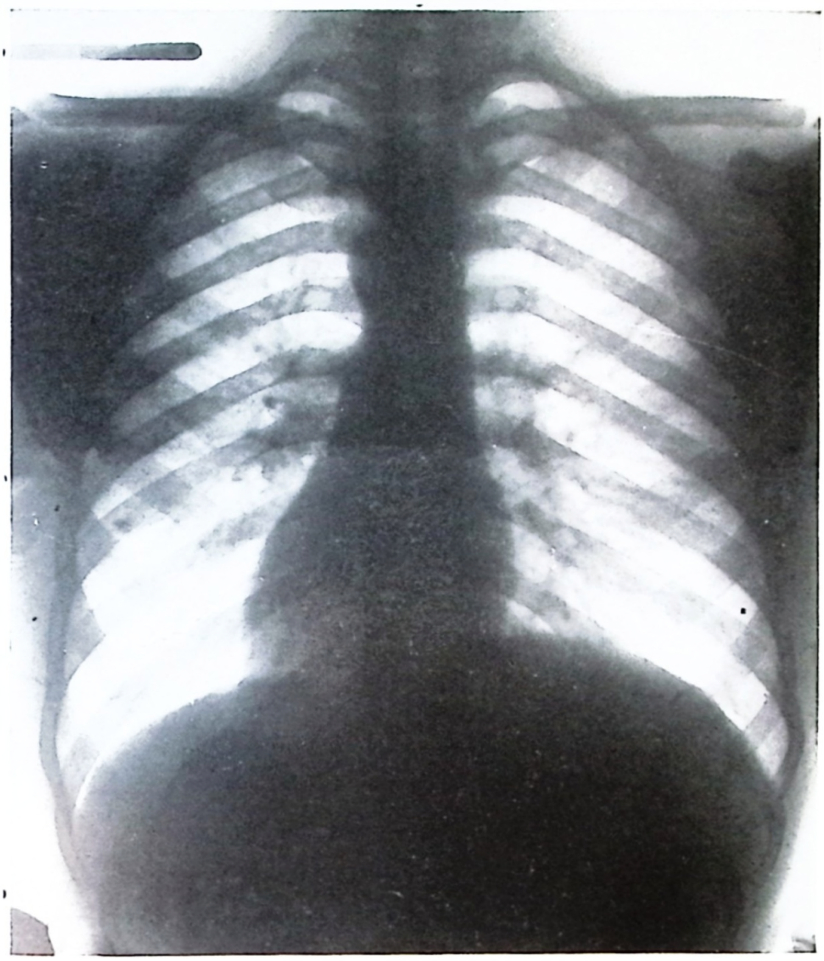


Figure No. 51a

CHEST — PA View

Technique

Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
50	72	¾ sec.	72″
150	70	1/10 sec.	72″

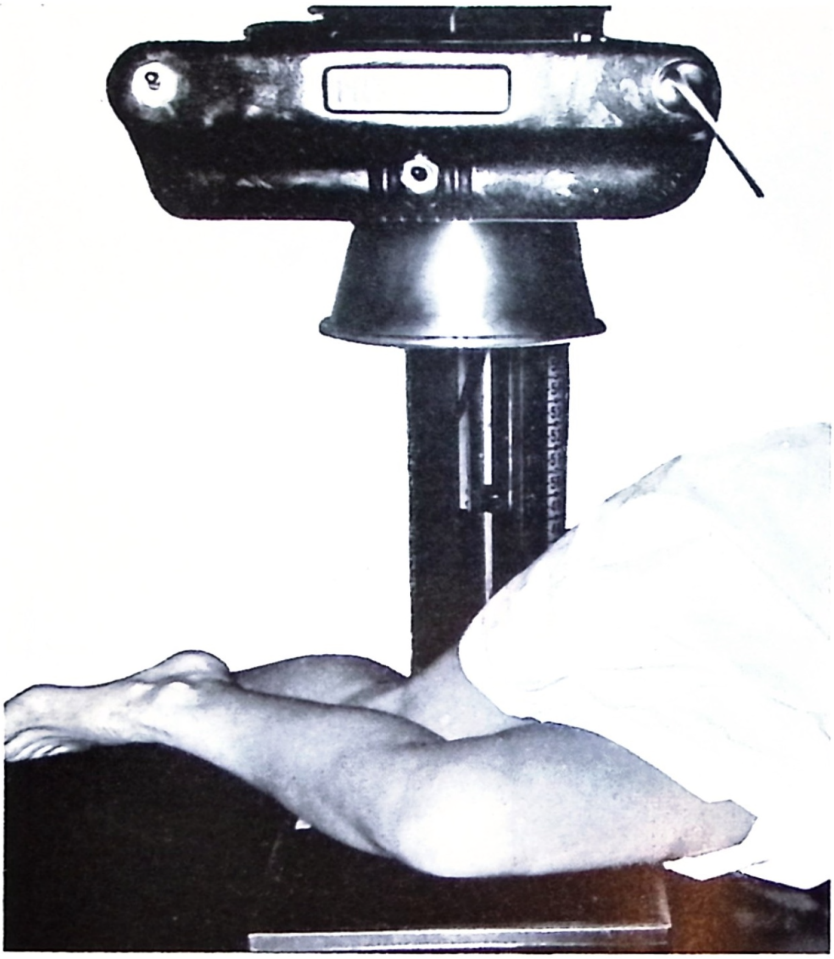


Figure No. 52

KNEE — Lateral View

Film—8x10.

Preparation—Clothing to be removed from this area.

Posture—The patient should be reclining on his side with the knee to be X-rayed nearest the table. The cassette is placed so as to show the knee in the center of the film. Use sand bags to immobilize.

Tube position—Tube is placed so as to direct the central rays at the knee perpendicularly to the cassette.

Description of the film—Shows contours of the lower extremity of the femur; its articulation with the tibia; the superior extremity of the tibia and fibulae, and the patella.

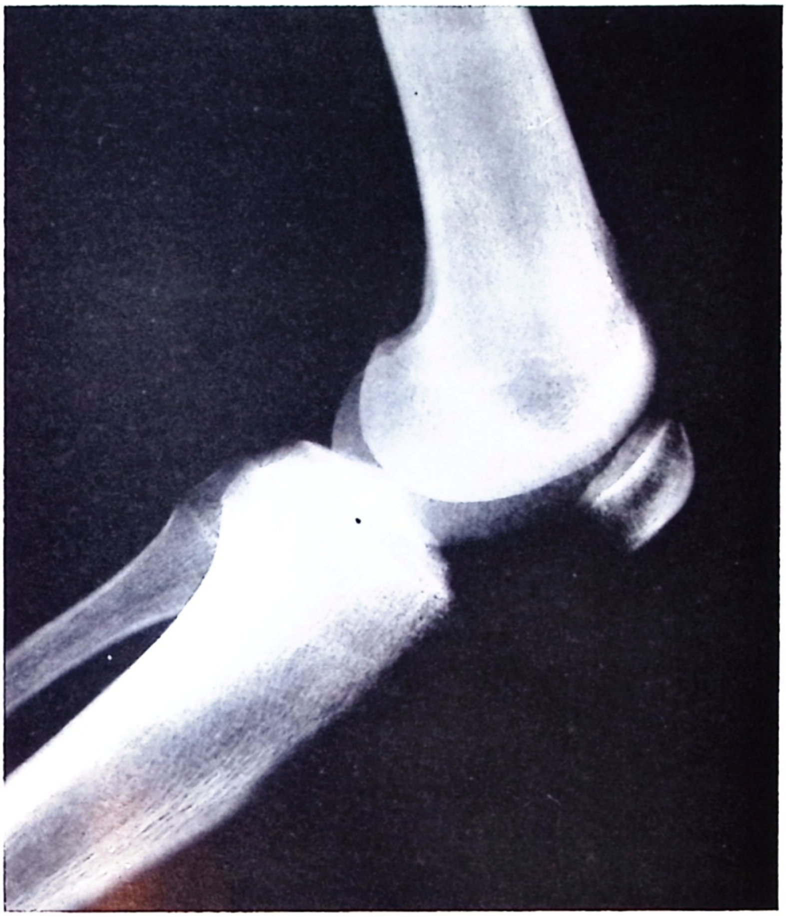


Figure No. 52a

KNEE — Lateral View

Technique
Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	55	3/4 sec.	36″
100	50	3/10 sec.	36″

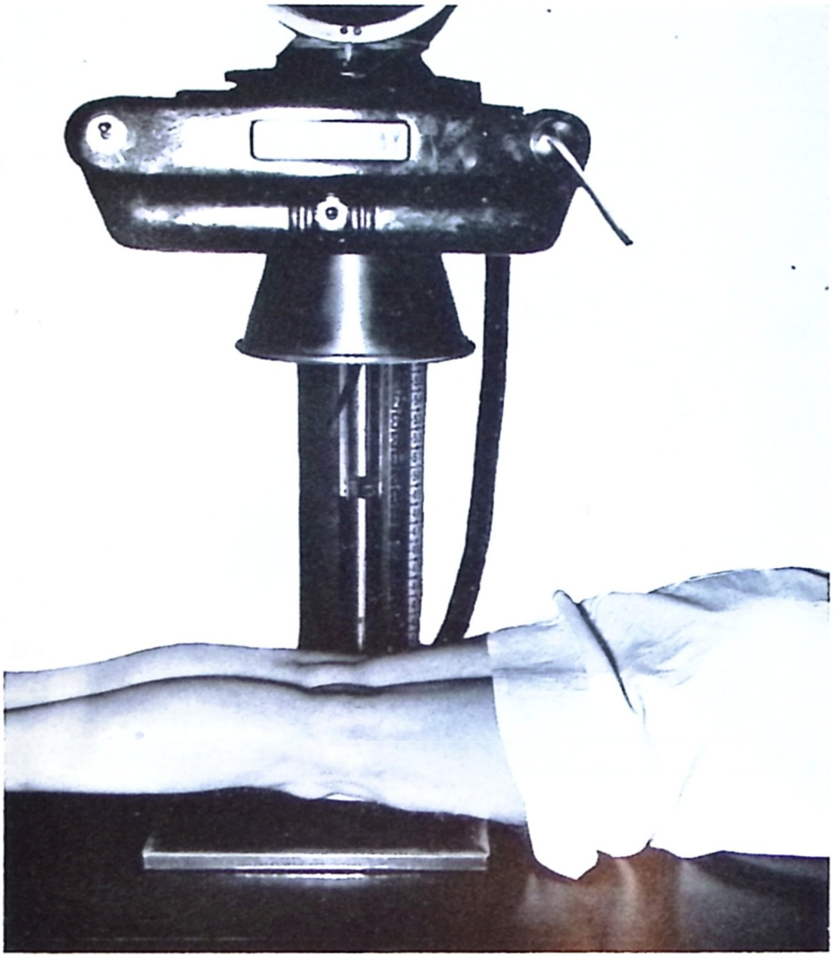


Figure No. 53

KNEE — PA View

Film—8x10.

Preparation—Remove clothing from the area to be X-rayed.

Posture—The patient is in a prone position, with the knee to be X-rayed in the center of the cassette. Immobilize the area with sand bags.

Tube position—Rays are directed at the knee, perpendicularly to the cassette.

Description of the film—Shows complete contour of the inferior extremity of the femur and its articulation with the tibia; the superior extremity of the tibia and fibula, and the outline of the patella superimposed upon the lower extremity of the femur. The epiphysial lines in the adult and the epiphysial separations in the children are shown.

Figure No. 53a

KNEE — PA View

Technique

Extra Speed Screens

Buck (Red Label) Film

Without Bucky

M.A.	KVP	Time	Tube Dist.
25	60	3/4 sec.	36″
100	52	3/10 sec.	36″

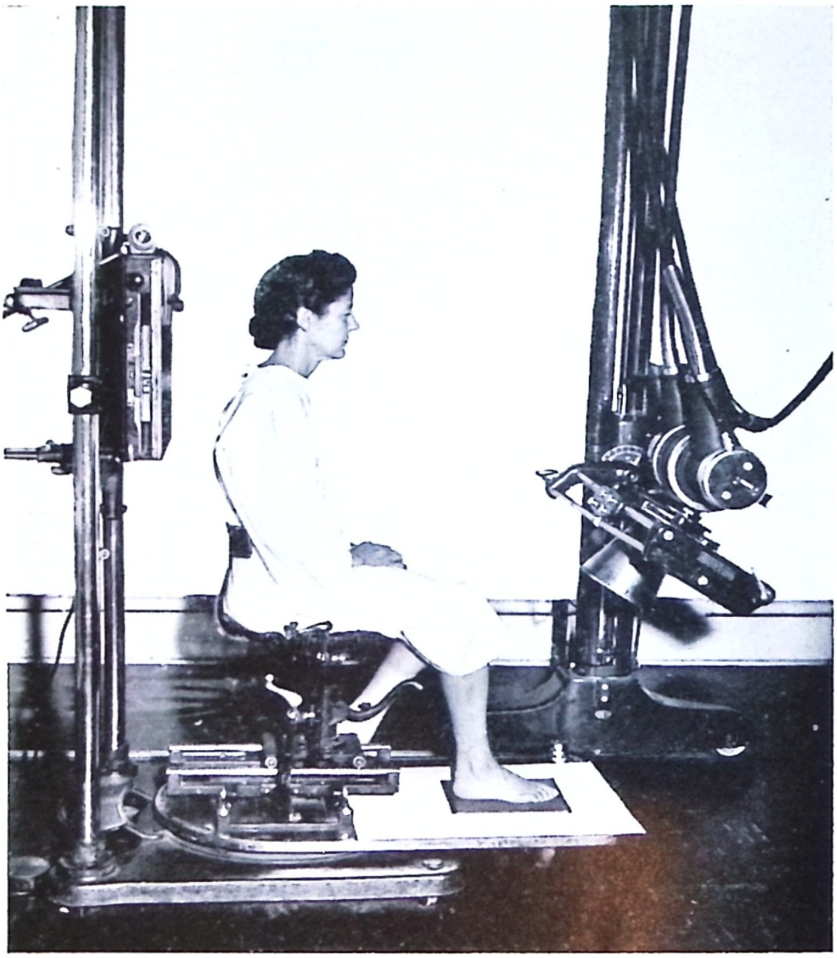


Figure No. 54

FOOT — AP View

Film—8x10.

Preparation—Clothing removed from this area.

Posture—The patient can be in either a sitting or standing position. If standing, the foot to be X-rayed is extended forward and rests flat on the cassette. If sitting, the foot is extended forward and rests flat on the cassette.

Tube position—The rays are directed to about the center of the foot at right angles to the contour of the top of the foot.

Description of the film—It is practically impossible to get any definite and distinct view of the os calcis from this position because there is a difference in the density and thickness between it and the phalangeal end of the foot.

Figure No. 54a

FOOT — AP View

Technique

No Screens
Buck (Red Label) Film
Without Bucky
With Cardboard Exposure Holder

M.A.	KVP	Time	Tube Dist.
25	50	3 sec.	36″
100	48	2 sec.	36″

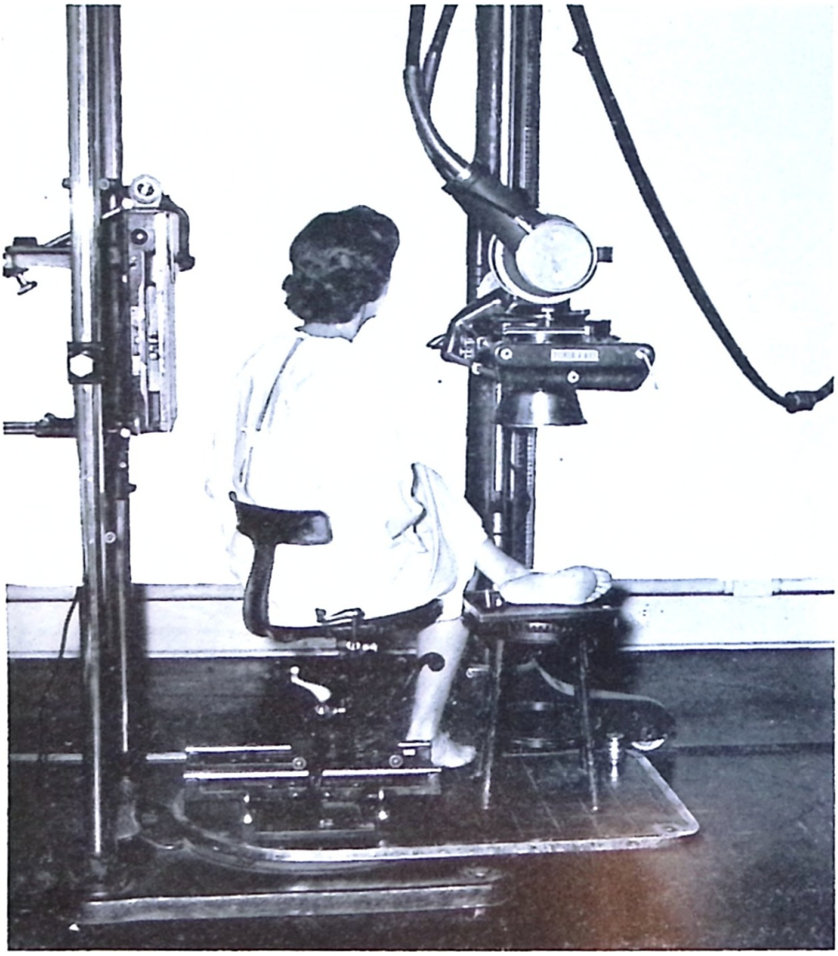


Figure No. 55

ANKLE — Lateral View

Film—8x10.

Preparation—Remove clothing from the area to be X-rayed.

Posture—The patient should be in either a sitting or reclining posture. The external side of the foot is flat on the cassette, with the ankle in the center of the film. Sand bags are used to immobilize this area.

Tube position—The tube should be placed so that the central rays are directed at the ankle and perpendicularly to the cassette.

Description of the film—Reveals the contour of the lower extremity of the tibia and fibula, the tarsals and their articular surfaces and spaces.

Figure No. 55a

ANKLE — Lateral View

Technique
Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	50	¾ sec.	36″
100	44	3/10 sec.	36″

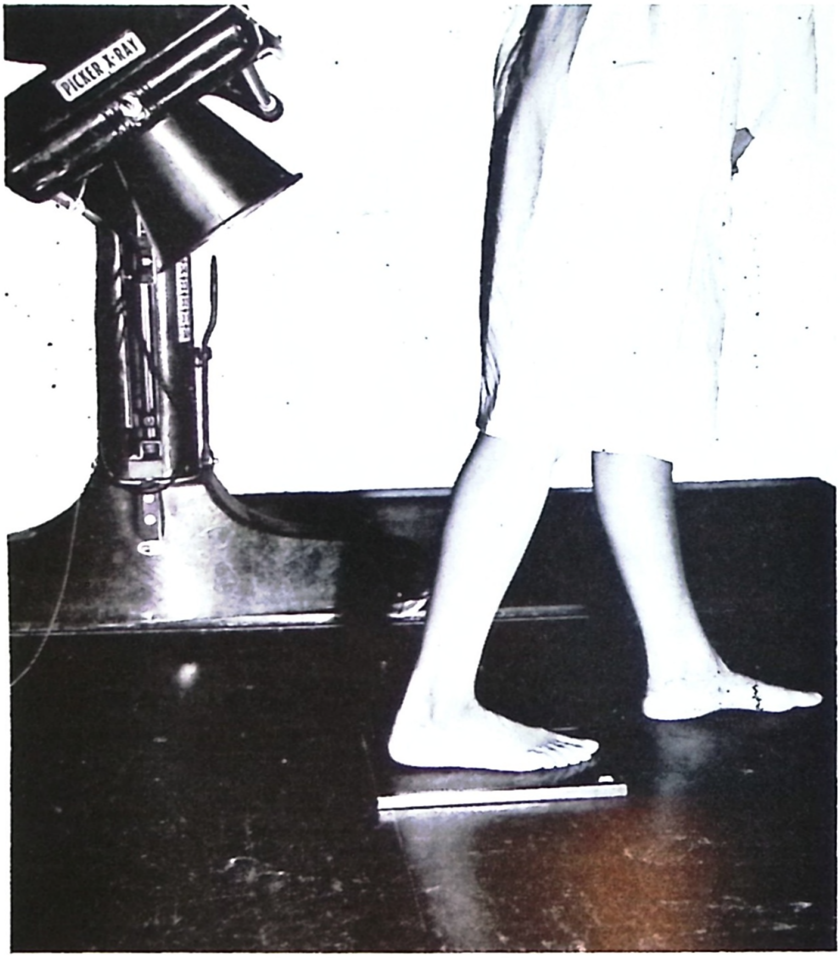


Figure No. 56

OS CALCIS — PA View

Film—8x10, lengthwise of foot.

Preparation—Remove clothing from this area.

Placement—Patient should either be standing with the foot to be X-rayed back, or he should be lying in a prone position with his toes on table. Film should be placed firmly against the plantar surface of the foot, and held firmly by sand bags or angle board.

Tube position—Rays are directed at the heel at about a 45 degree angle with the cassette.

Description of the film—Reveals contour of posterior and lateral margins of os calcis, the epiphysial lines in adults and the epiphysial separations in children.

Figure No. 56a

OS CALCIS — PA View

Technique
Extra Speed Screens
Buck (Red Label) Film
Without Bucky

M.A.	KVP	Time	Tube Dist.
25	55	¾ sec.	36″
100	48	½ sec.	36″

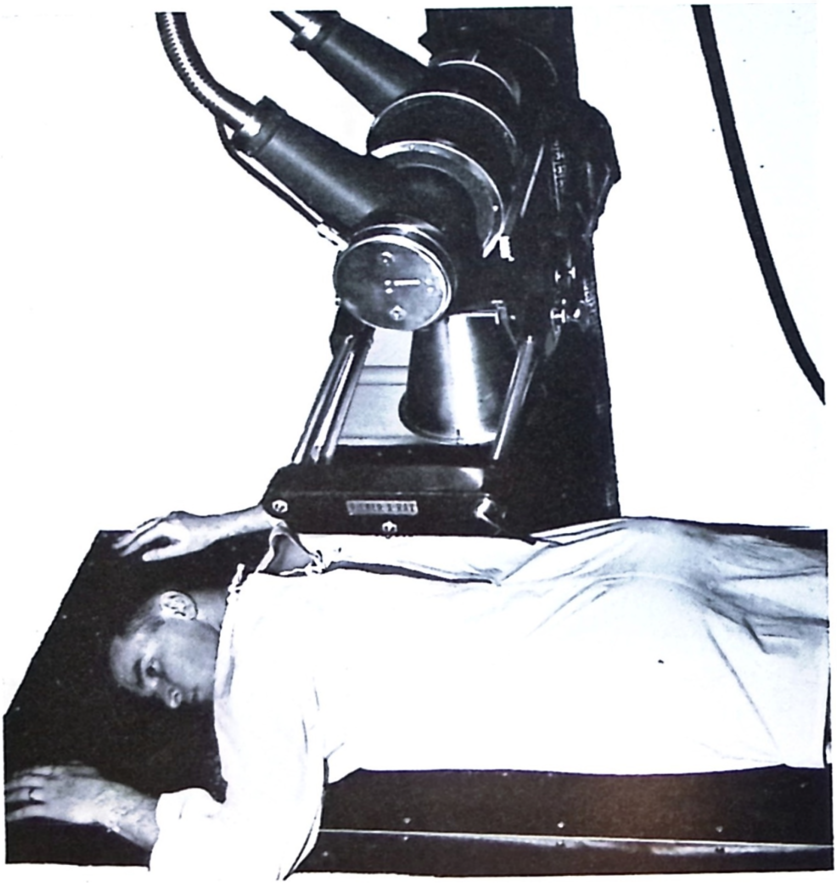


Figure No. 57

GALL BLADDER—PA View

Figure No. 57a

GALL BLADDER
(Position slightly lower than normal)

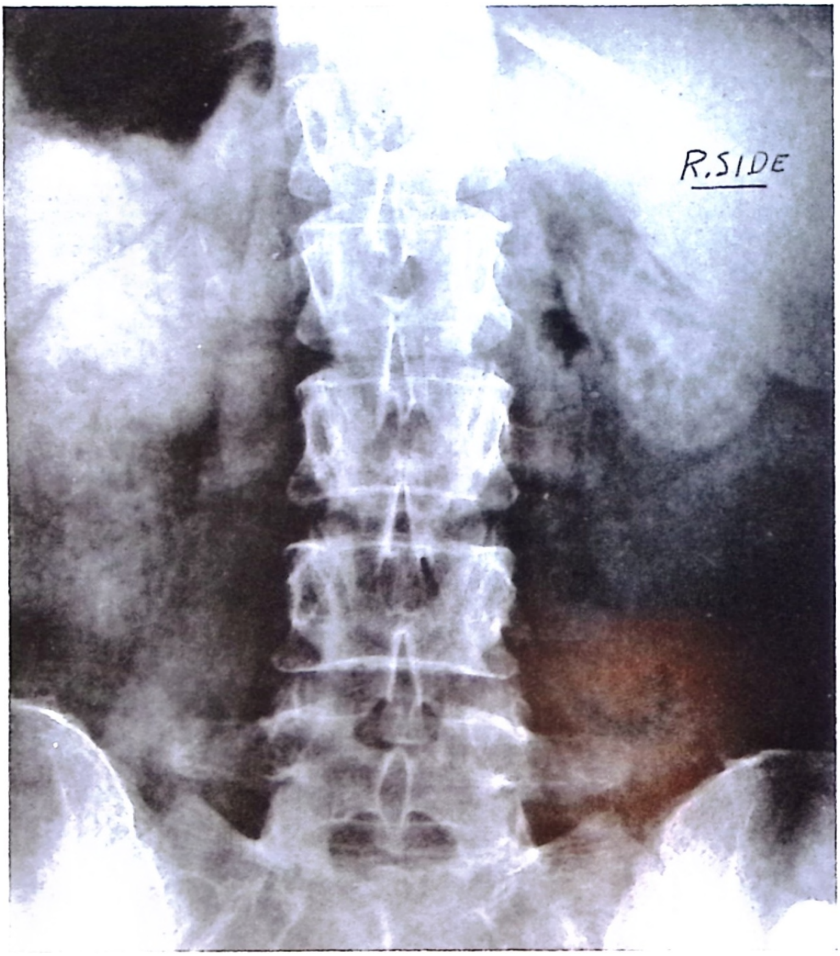


Figure No. 58

GALL BLADDER, Revealing Stones

GALL BLADDER — PA View

Film—14x17 parallel with spine. This film is advantageous, at least until gall bladder is located.

Preparation—One hour after a fat-free evening meal, patient takes the required number of dye tablets of Priodex or Telepaque (usually about 6) with a little water or fruit juice. If there are acute abdominal symptoms, consult a physician before taking these tablets. X-ray examination should be made early the next morning or about 12 hours after taking the dye. The dye-filled gall bladder should be visible at this time. Clothing removed over gall bladder area.

Placement—Patient lies on the abdomen with his left side elevated slightly. Rays are directed perpendicular to the film, about 2 inches right of the 12th dorsal and just inferior to the last pair of ribs. Sometimes, however, the gall bladder is found below the superior crest of the ilium. In that event, retake the case so as to center tube over the gall bladder. Patient should hold his breath and the exposure be made rapidly. Use a small cone to obtain the best results.

GALL BLADDER — PA View

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
50	68	3¼ sec.	60″
100	64	2 sec.	60″

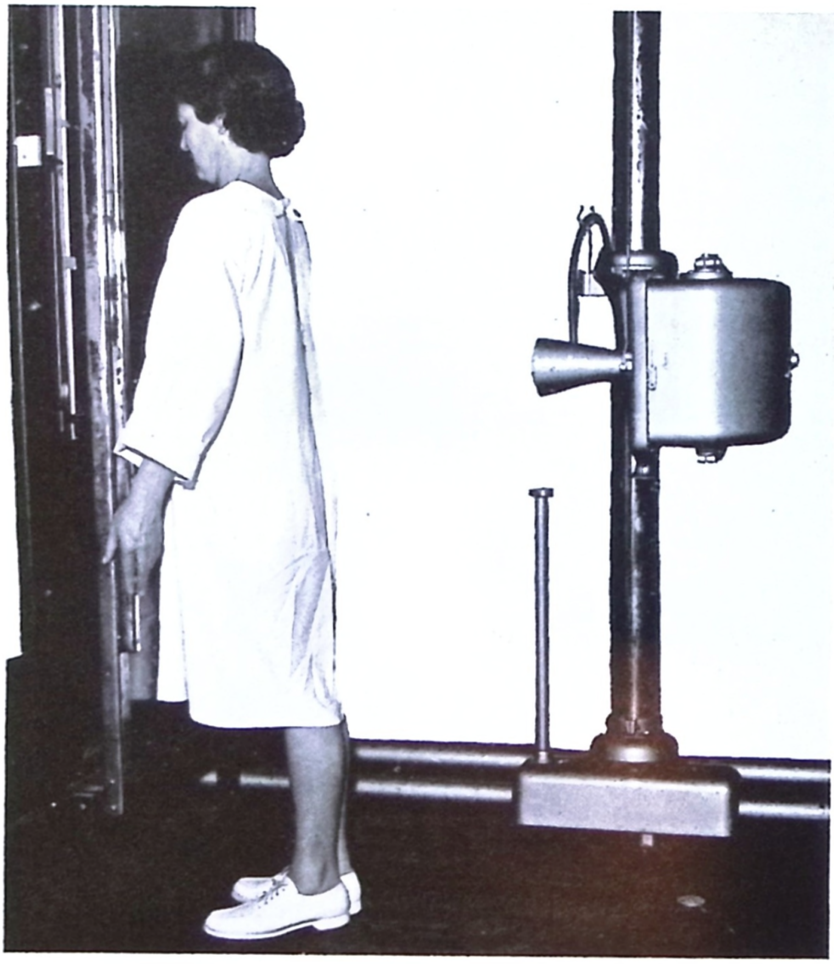


Figure No. 59

STOMACH—PA View

Figure No. 59a

STOMACH

Technique (Standing)

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	65	4 sec.	30″
100	70	2 sec.	48″

STOMACH AND COLON — PA View

Technique and other procedure for gastro-intestinal work will vary with the individual case and according to the experience and desires of the radiologist. Medicines and cathartics must not be given during the period of examination. Patient may take a cathartic, enema or resume medical treatment after the exposures are completed.

The gastro-intestinal tract offers about the same density as the surrounding tissue. It cannot be radiographically visible without being made opaque to the X-rays. Therefore, a barium sulphate meal is given just prior to the examination. The examination may include the fluoroscope immediately following the barium meal, and several X-ray exposures at different intervals—depending on the condition of the case and how much of the tract one desires to examine. When the lower bowel and rectum are examined, usually a barium enema is given. About one-third more barium with a small amount of powdered gum-acacia added will obtain better results, particularly throughout the colon area.

A complete examination of the gastro-intestinal tract takes about 20 hours, at 4 to 5 hour intervals. The stomach normally empties in about 4 hours. Growths, crevices or restricted areas may add to the time it empties. This, of course, may vary with a particular patient.

Preparation—3 to 4 oz. of barium sulphate or Gastropaque (for the stomach) to a glass of warm water. This should be thoroughly mixed an hour or so in advance of the examination to eliminate any air bubbles—and restirred thoroughly just before it is given to the patient.

For the colon, give up to 5 oz. and slightly more fluid, depending upon the size of the patient and his condition.

The patient should present himself with an empty stomach, at about 9 a.m., for the first stomach exposure. Then he returns at intervals if further examination and exposures are desired. He should not eat until the examination is completed. Clothing must be removed and a cotton gown substituted. Usually some sort of marker is used to locate the umbilicus on the film for the purpose of comparing it in relation to the position of the stomach.

Placement—Both standing and prone positions are used. Patient's arms placed at sides, with head turned to allow closer position to the film. Film centered about 2 inches above the umbilicus, or according to other portions of the tract to be examined. X-rays directed perpendicularly to the horizontal and vertical center of the cassette.

FILM No.

PAID
NO. ________
YES ________

NAME ________________________________
ADDRESS ________________________________
CASE REFERRED BY ________________________________
ADDRESS ________________________________

LAT. VIEW NATURAL

Axis ________________________________
Atlas ________________________________
Cerv. Curvature ________________________________
Malformation ________________________________

A P VIEW NATURAL

Occiput ________________________________
Axis ________________________________
Atlas Wedge ________________________________
Atlas Rotation ________________________________
Atlas Laterality ________________________________
Cerv. Curvature ________________________________
Malformation ________________________________

BASE POSTERIOR

Axis Rotation ________________________________
Atlas Rotation ________________________________

NASIUM

Axis ________________________________
Atlas Laterality ________________________________
Malformation ________________________________

STEREO

Axis ________________________________
Atlas ________________________________

A P NAT. and B P COMBINATION

A P VIEW
Axis body to med. line ________________________________

B P VIEW
Atlas in relation to axis ________________________________

Atlas on condyles ________________________________

FINAL ANALYSIS—
Occiput ________________________________
Atlas ________________________________
Axis ________________________________

DATE ____________
NAT. ____________
STEREO. ____________
EXTREM. ____________
REGIONAL ____________
SOFT TISSUE ____________

Cervical
Atlas ____________
Axis ____________
3rd ____________
4th ____________
5th ____________
6th ____________
7th ____________

Dorsal
1st ____________
2nd ____________
3rd ____________
4th ____________
5th ____________
6th ____________
7th ____________
8th ____________
9th ____________
10th ____________
11th ____________
12th ____________

Lumbar
1st ____________
2nd ____________
3rd ____________
4th ____________
5th ____________

Sacrum ____________

Ilium ____________

Coccyx ____________

Remarks: ________________________________

____
Analyst or Spinographer

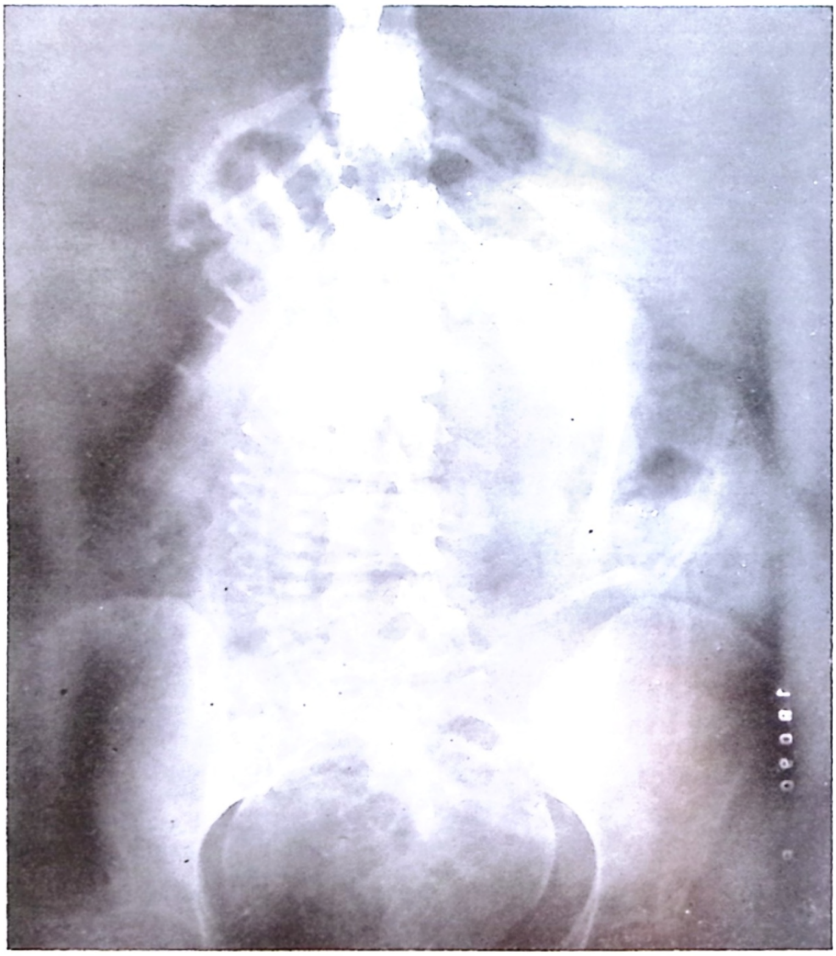


Figure No. 61

PREGNANCY—AP View

PREGNANCY — AP View

Frequently this question is asked: "Is it advisable to X-ray the foetus or the mother during pregnancy?" Since it is said that X-radiation affects the genes and future generations, it seems only common sense to X-ray only when it is absolutely necessary. This applies to babies, as well. Scientists researching the effects of X-radiation state that at present about 2 per cent of all children in the United States are born with some noticeable genetic defect. Because all radiation may be dangerous—even from the natural background—it seems obvious that each X-ray exposure could only add to the possible injury. So don't X-ray your baby or baby-to-be just to be curious. If symptoms demand spinographs, then take them—but only when necessary.

The foetal skeleton cannot be demonstrated radiographically under 4 or 5 months. Even though outlines may be visible, the size of the foetal head and the mother's pelvis cannot be accurately compared because the head of the foetus is farther away from the film than the outlet of the mother's pelvis. Outlines usually are not sharp, due to foetal movement, a certain amount of fluid and because of the distortion. The exposure should be rapid, using the least amount of kilovolt so as not to over-expose the radiograph. Over-penetration is often the result because of the X-ray resistance to the foetal spine as compared with the resistance offered by the mother's pelvis.

Preparation—Cotton gown. 14x17 film.

Placement—Patient lies supine or takes a standing position. Rays directed perpendicular to film and centered midway between the umbilicus and symphysis pubis. However, this will vary somewhat during the stages of pregnancy. It is advisable to have patient hold her breath during the exposure. Should the mother's pelvis be extremely large, a lateral view may produce a more detailed image of the foetus.

PREGNANCY — AP View

Technique

Extra Speed Screens

Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
50	65-70	3 sec.	48″
100	78	$4\frac{1}{4}$ sec.	72″

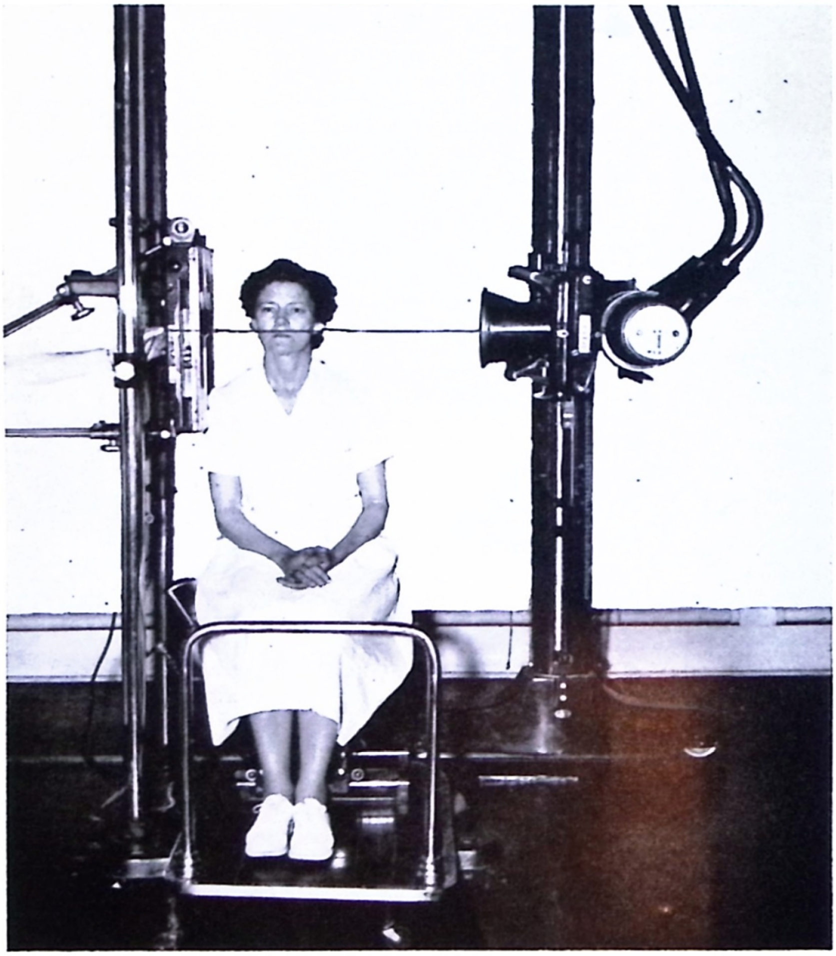


Figure No. 62

LATERAL CERVICAL
(Refer to Chapter 20 for the placement information)

Figure No. 62a

LATERAL CERVICAL VIEW

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	65	2 sec.	30″
100	62-64	1¼ sec.	60″

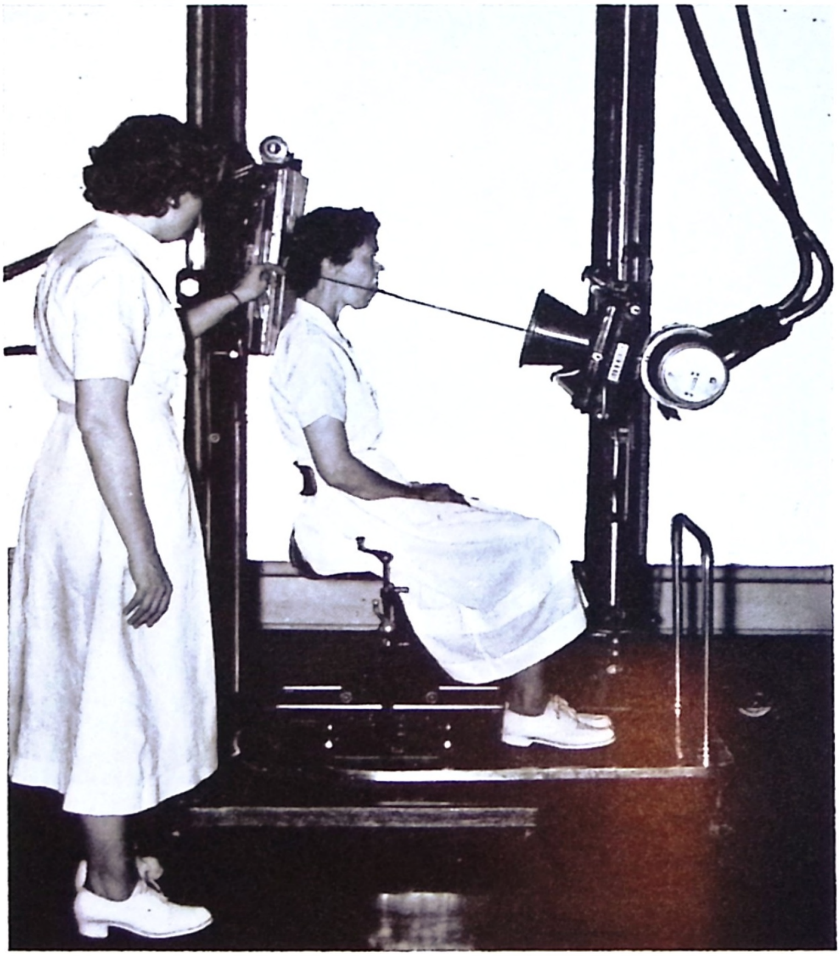


Figure No. 63

AP NATURAL CERVICAL
(Refer to Chapter 20 for the placement information)

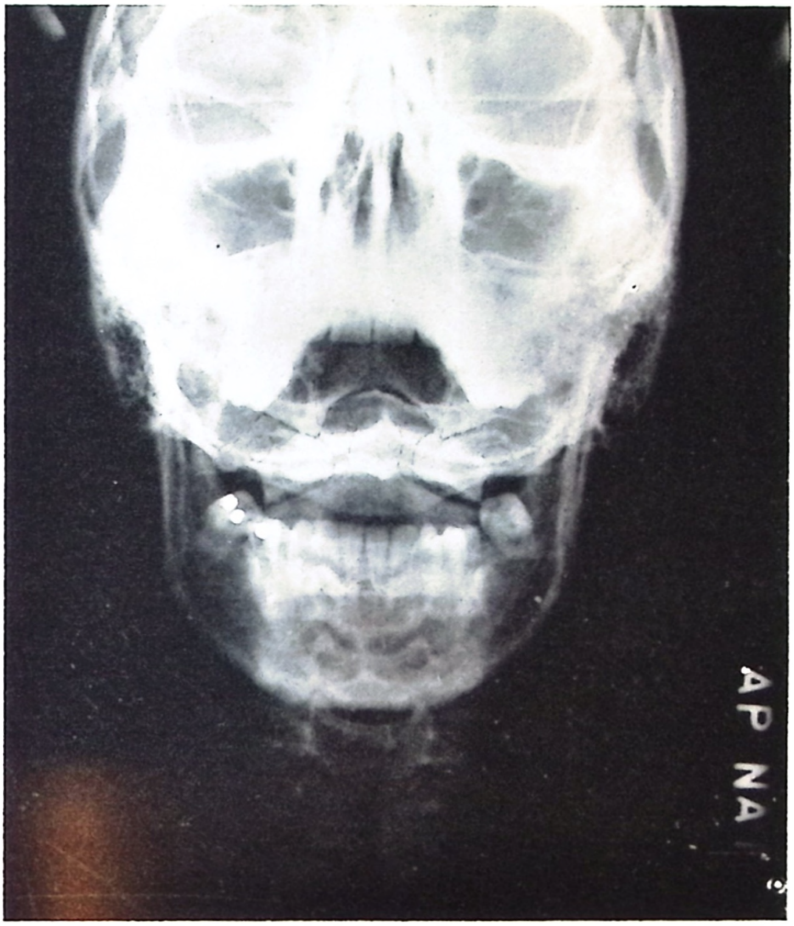


Figure No. 63a

AP NATURAL CERVICAL VIEW

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	76-80	3 sec.	30″
100	72-74	2 sec.	60″

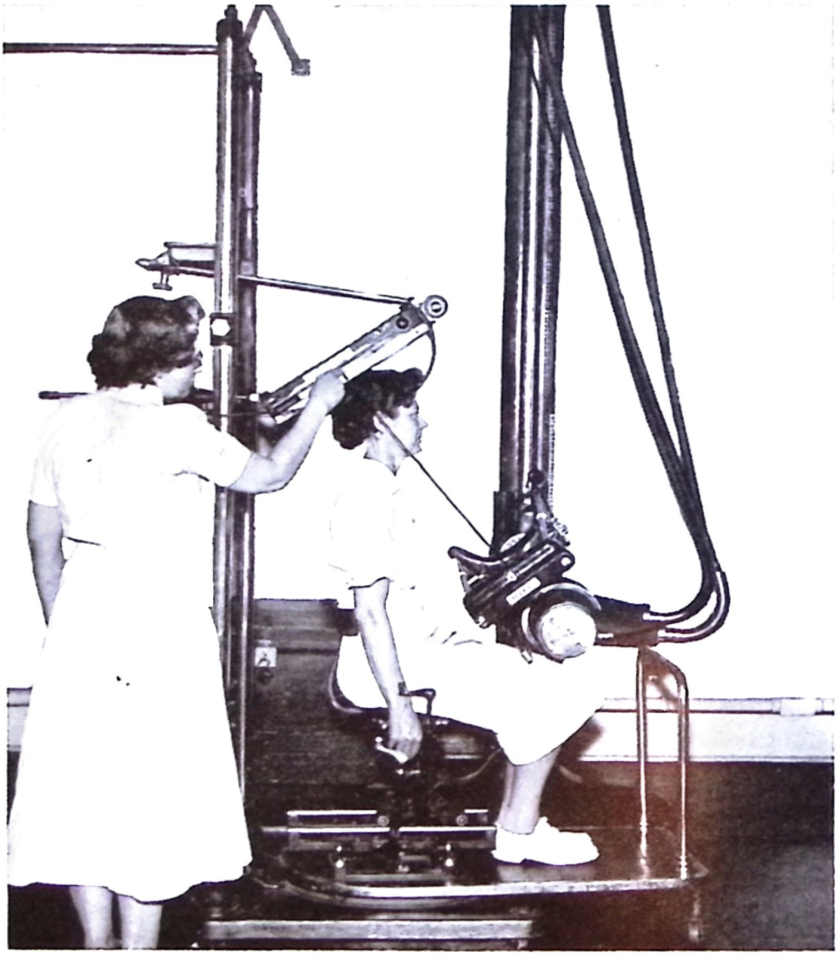


Figure No. 64

BASE POSTERIOR

(Refer to Chapter 20 for the placement information)

Figure No. 64a

BASE POSTERIOR VIEW

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	72-74	3 sec.	32″
100	72-74	1 to 1¼ sec.	32″

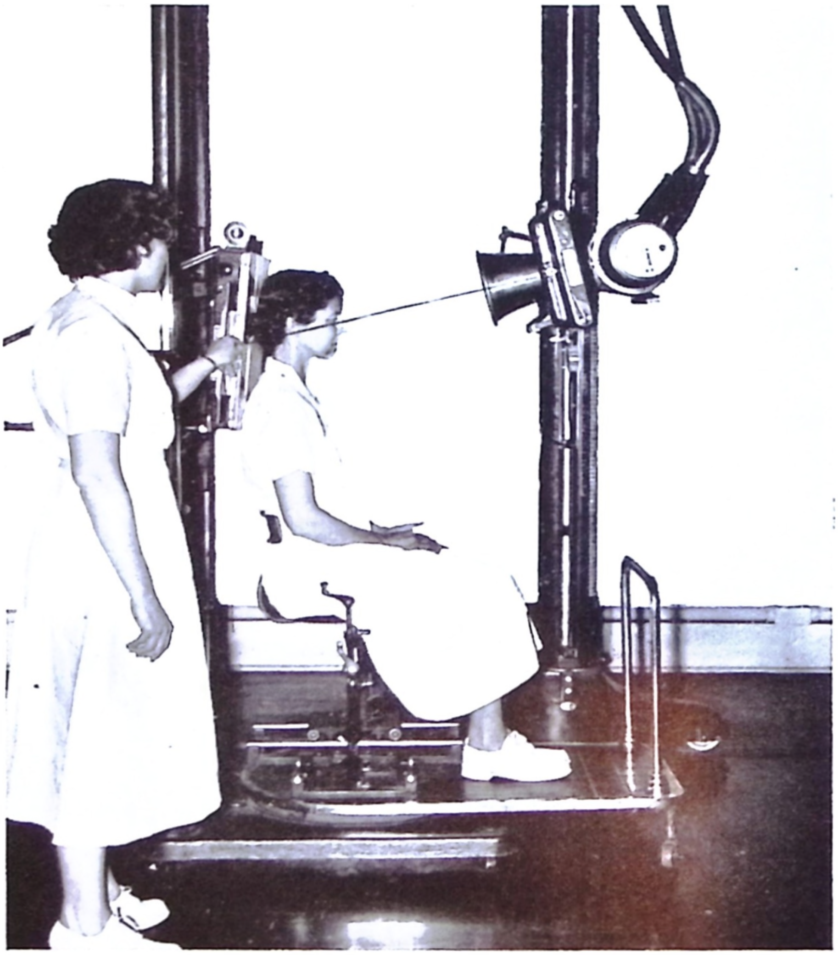


Figure No. 65

NASIUM
(Refer to Chapter 20 for the placement information)

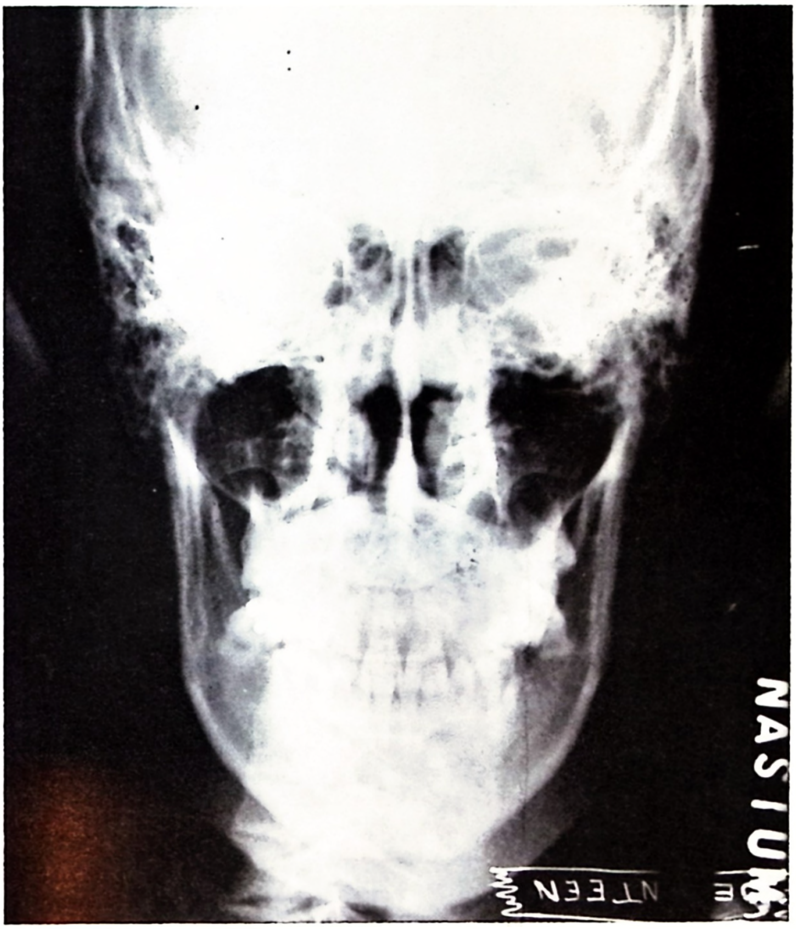


Figure No. 65a

NASIUM — AP View

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	72	3 sec.	30″
100	72-74	2 sec.	72″

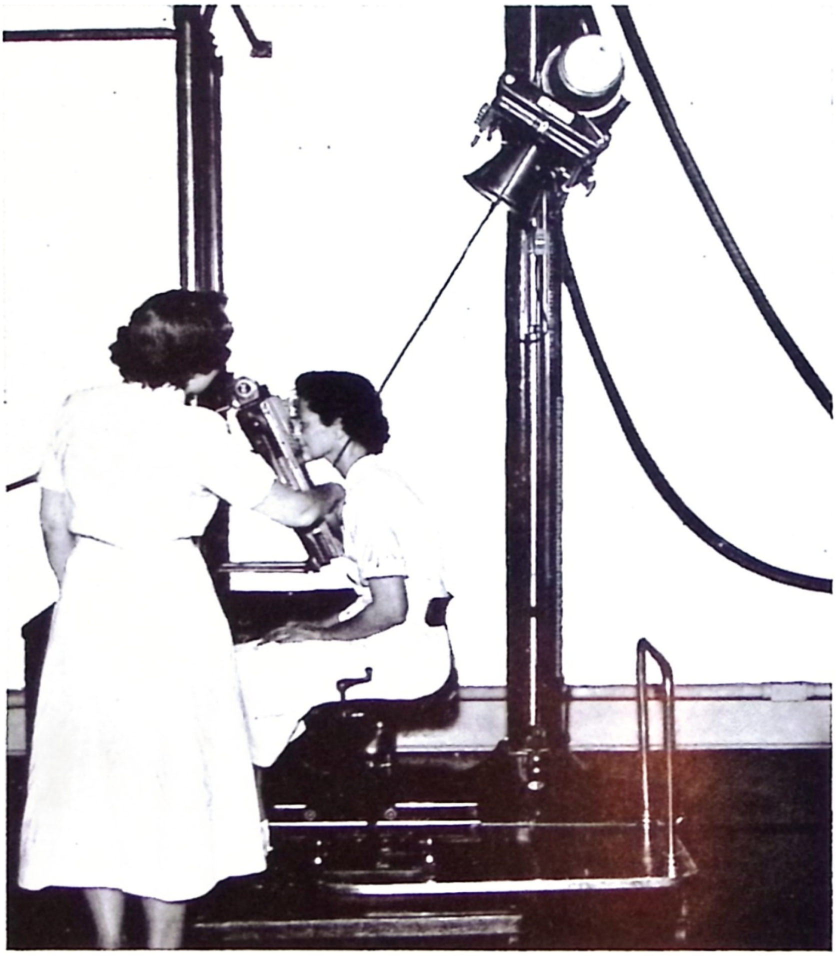


Figure No. 66

VERTEX—PA
(Refer to Chapter 20 for the placement information)

Figure No. 66a

VERTEX — PA View

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	76-80	6 sec.	30″
100	72-74	3 sec.	60″

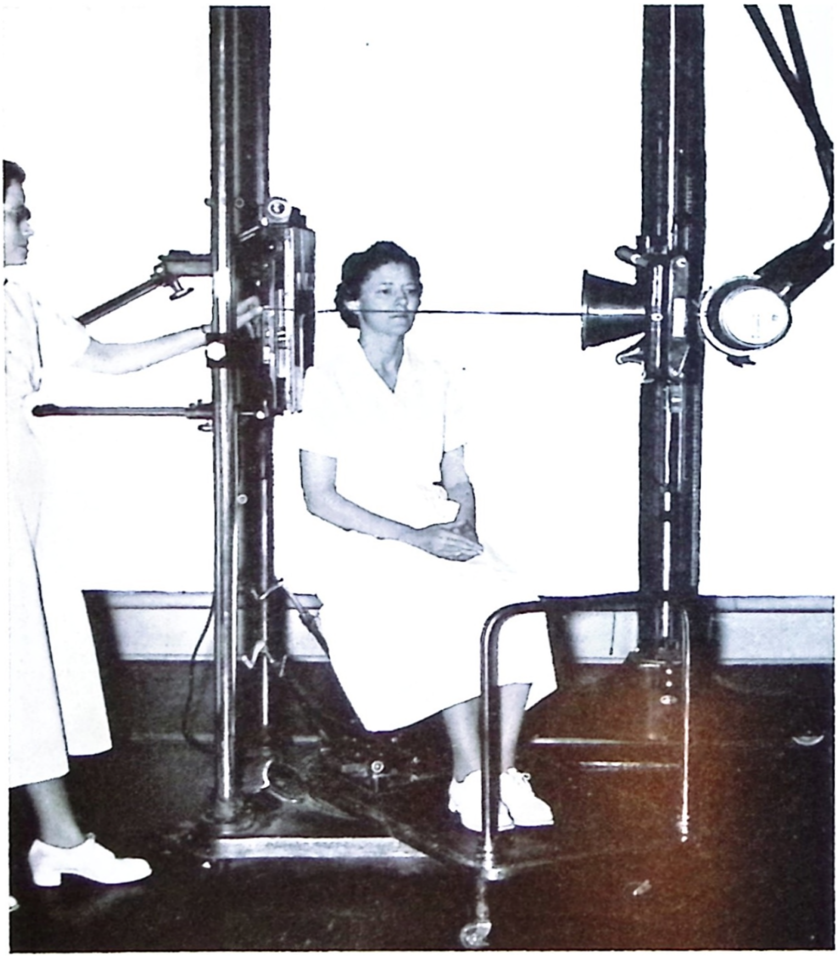


Figure No. 67

DIAGONAL CERVICAL

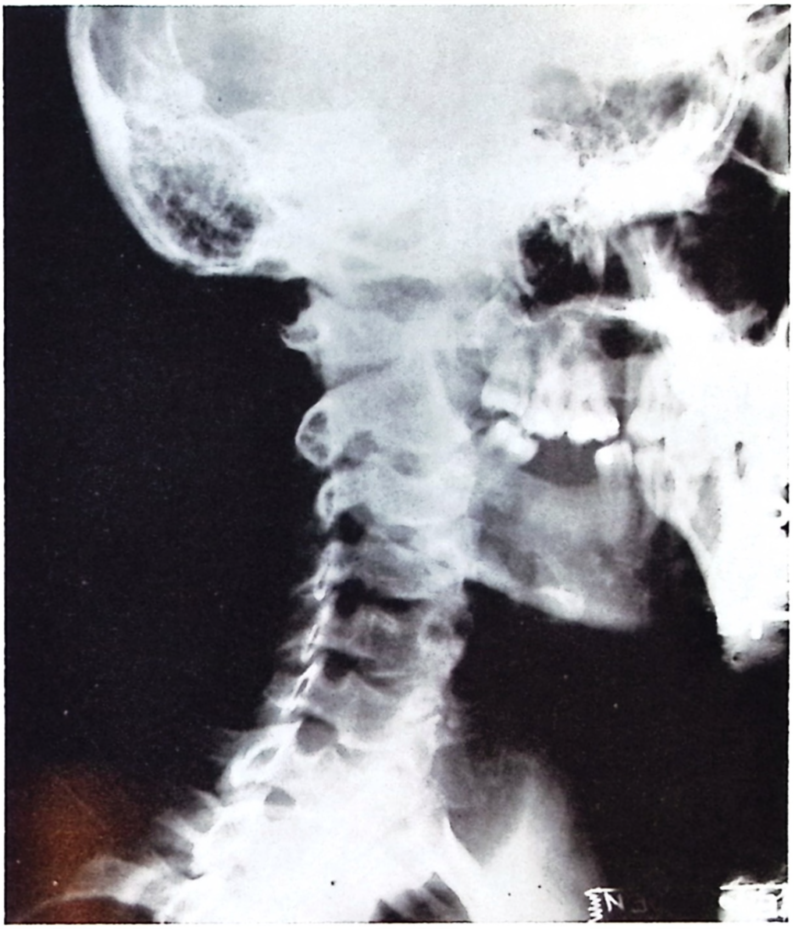


Figure No. 67a

DIAGONAL VIEW

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	60	2 sec.	30″
100	64-66	1½ sec.	60″

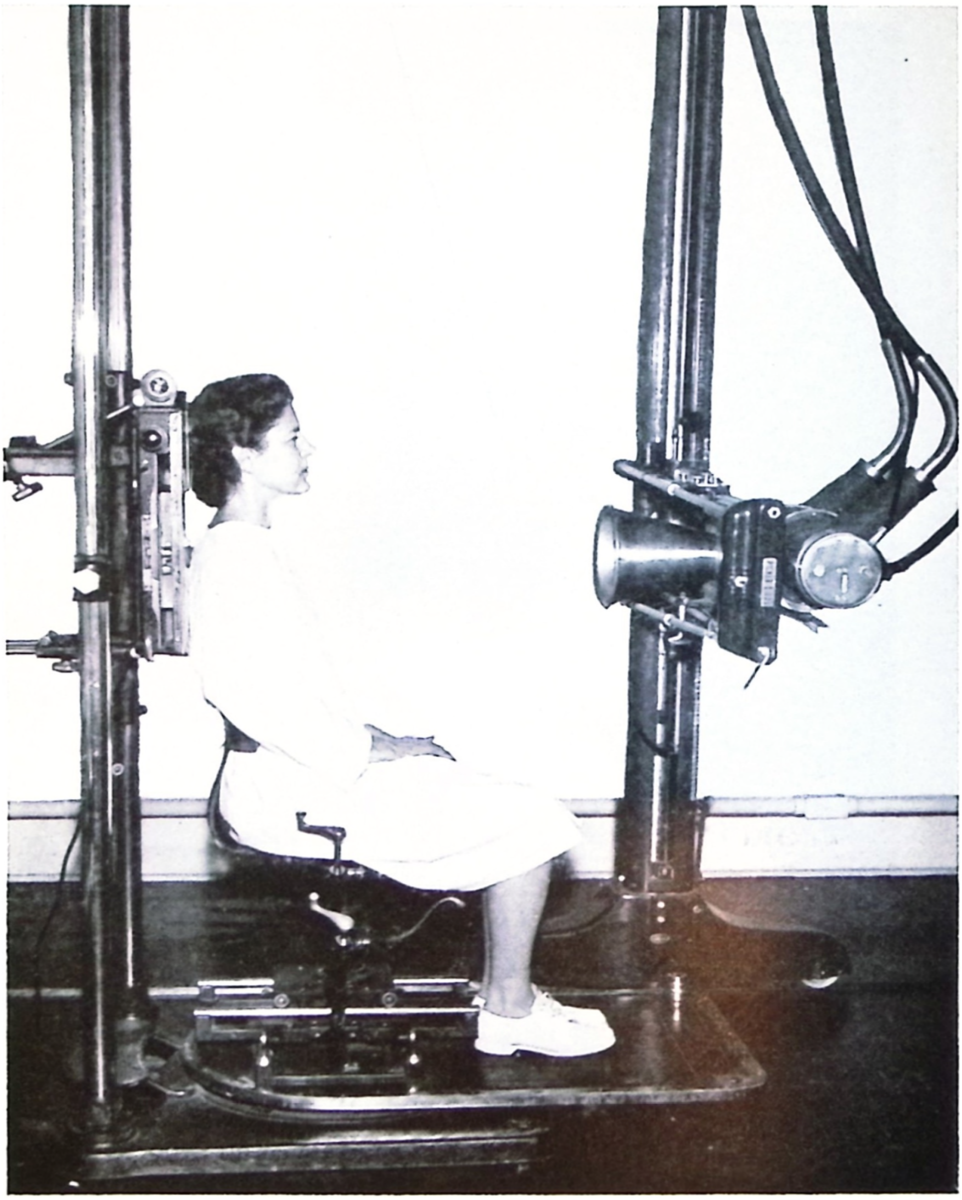


Figure No. 68

LOWER CERVICAL AND UPPER DORSAL (L.C.U.D.)
(Refer to Chapter 20 for the placement information)

Figure No. 68a

LOWER CERVICAL AND UPPER DORSAL (L.C.U.D.)

Sectional 8x10

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	70	3½ sec.	30″
100	64	1½ sec.	60″

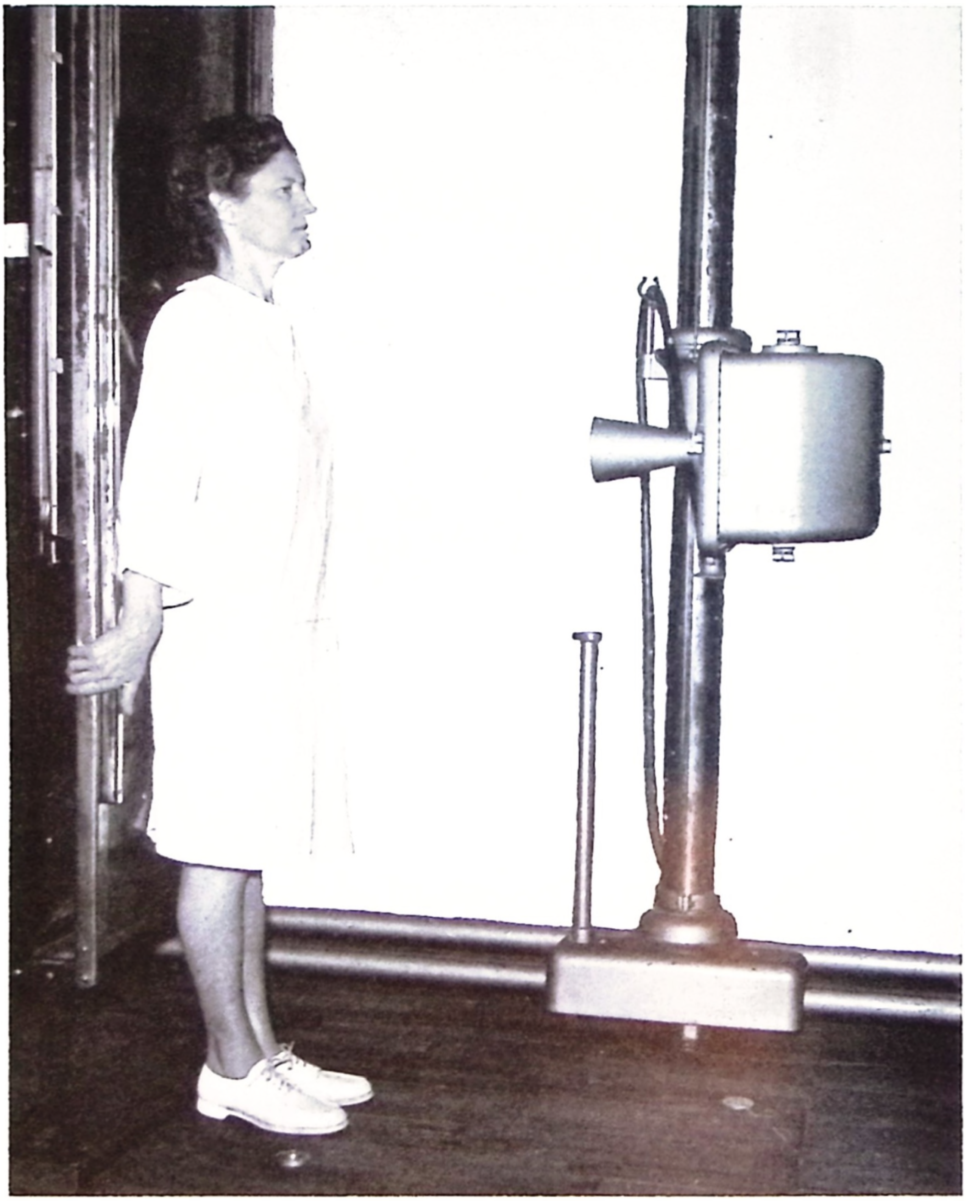


Figure No. 69

LOWER DORSAL (L.D.)

(Refer to Chapter 20 for the placement information)

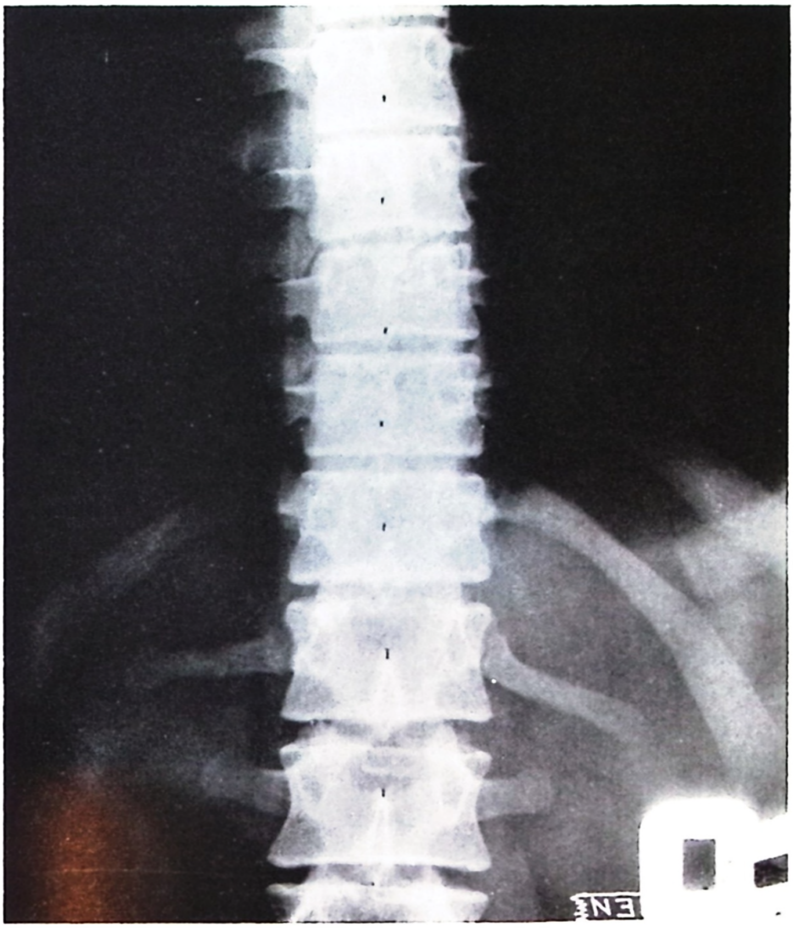


Figure No. 69a

LOWER DORSAL (L.D.)

Sectional 8x10

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	70	3½ sec.	30″
100	68	2 sec.	60″

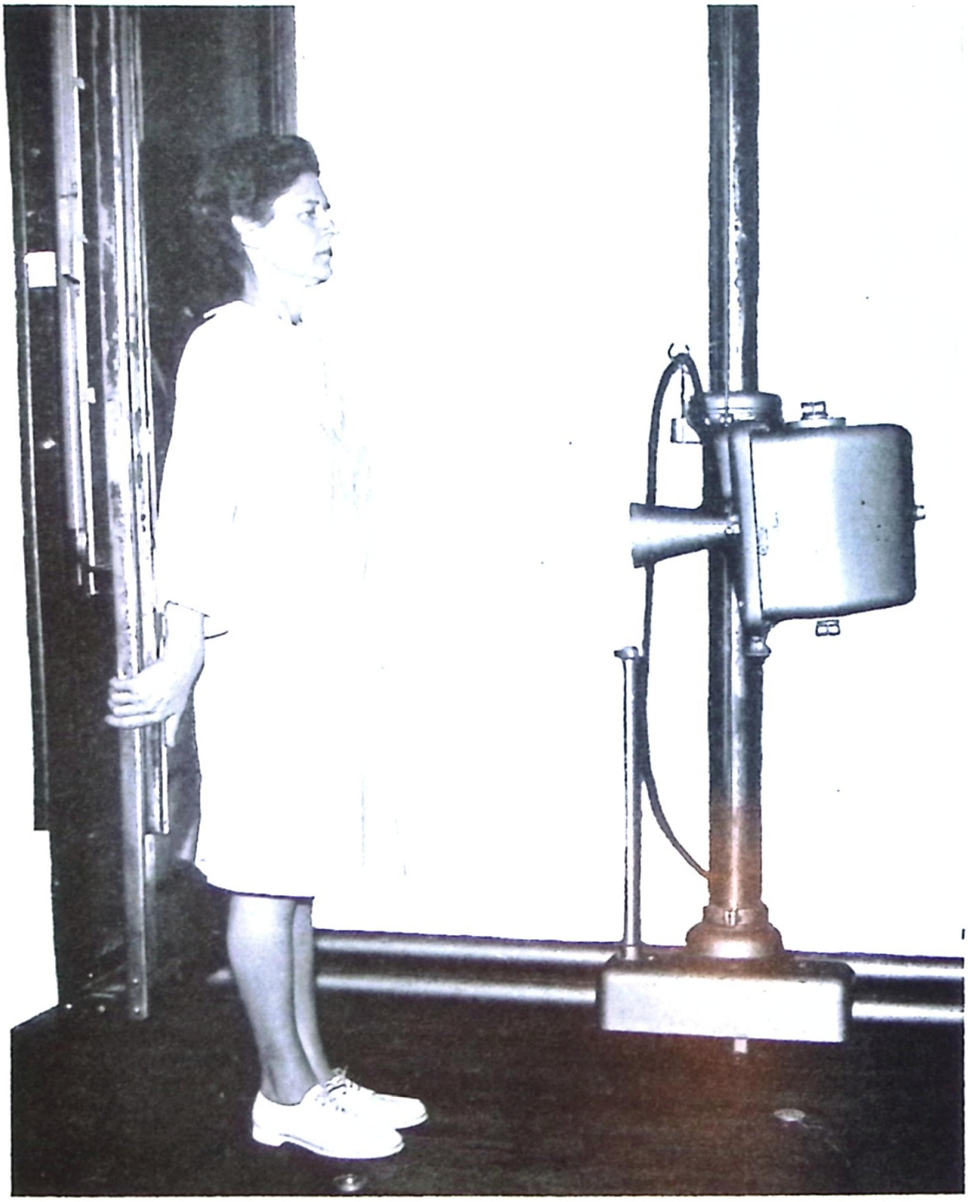


Figure No. 70

LUMBAR

(Refer to Chapter 20 for the placement information)

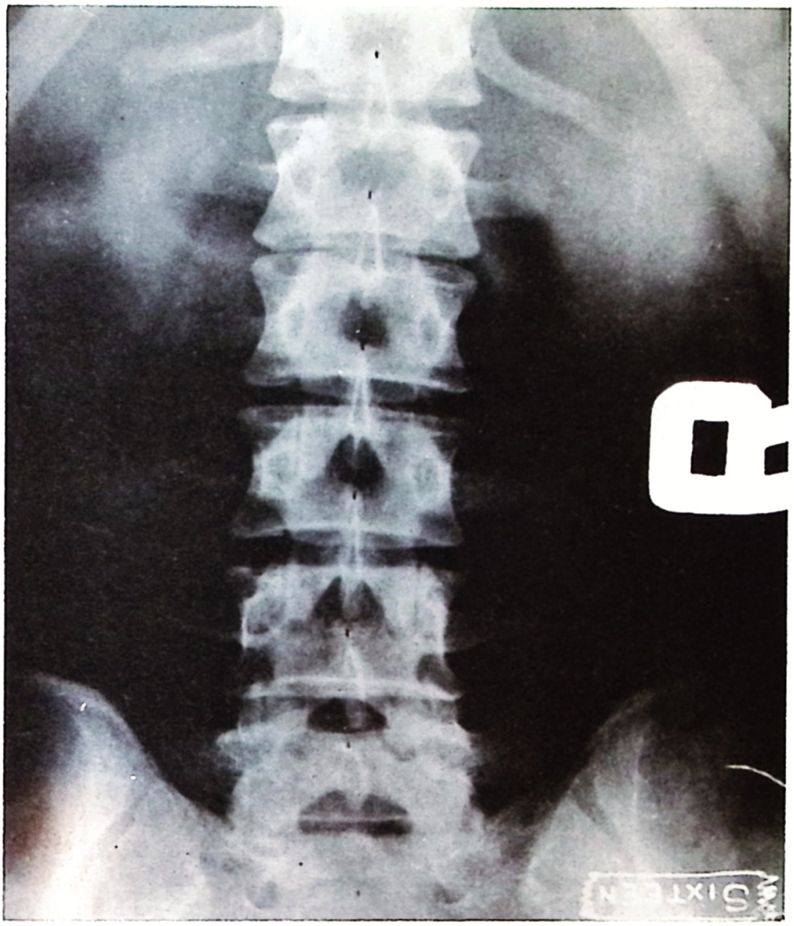


Figure No. 70a

LUMBAR — AP View

Sectional 8x10
Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	75	4 sec.	30″
100	68	3¼ sec.	60″

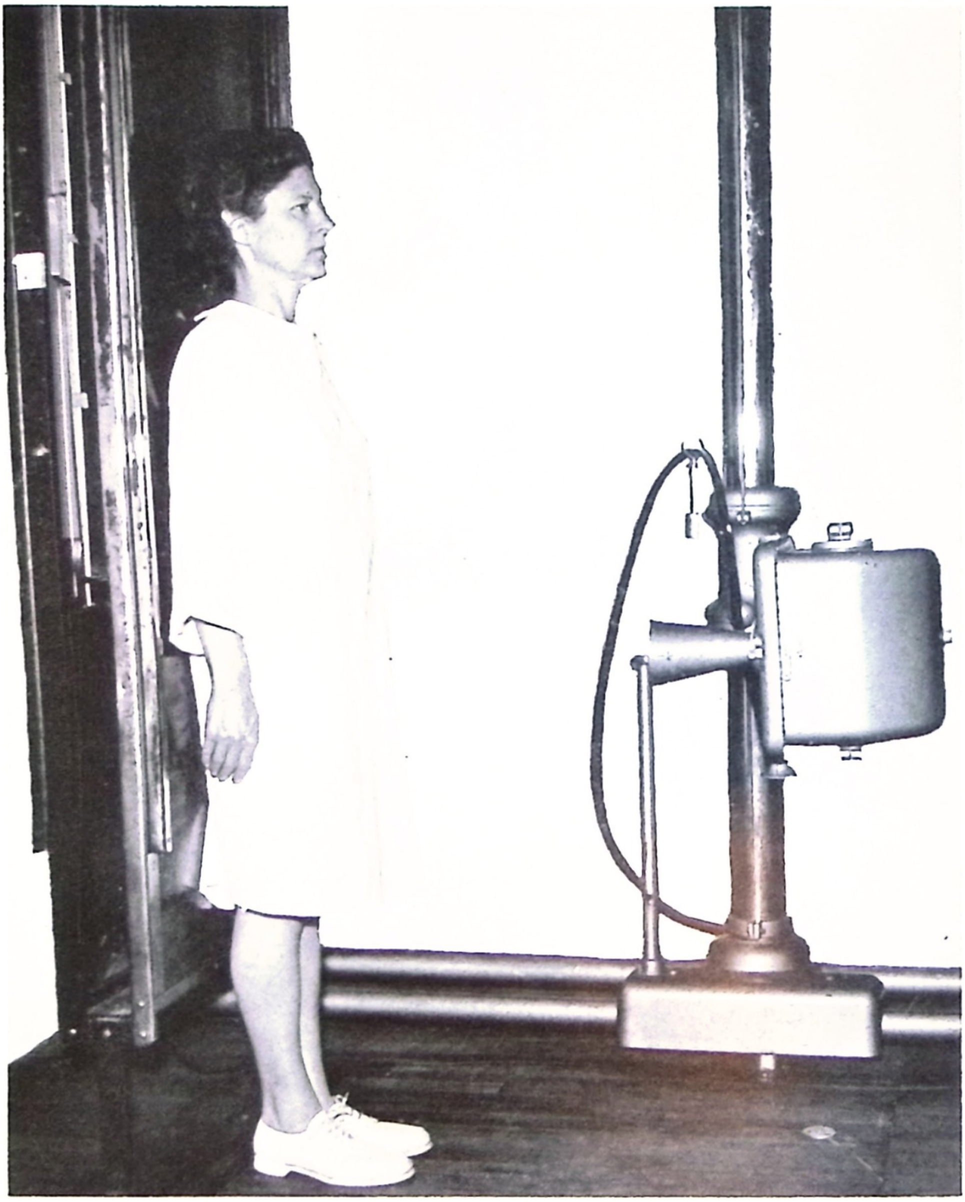


Figure No. 71

SACRUM AND COCCYX — AP View

(Refer to Chapter 20 for the placement information)

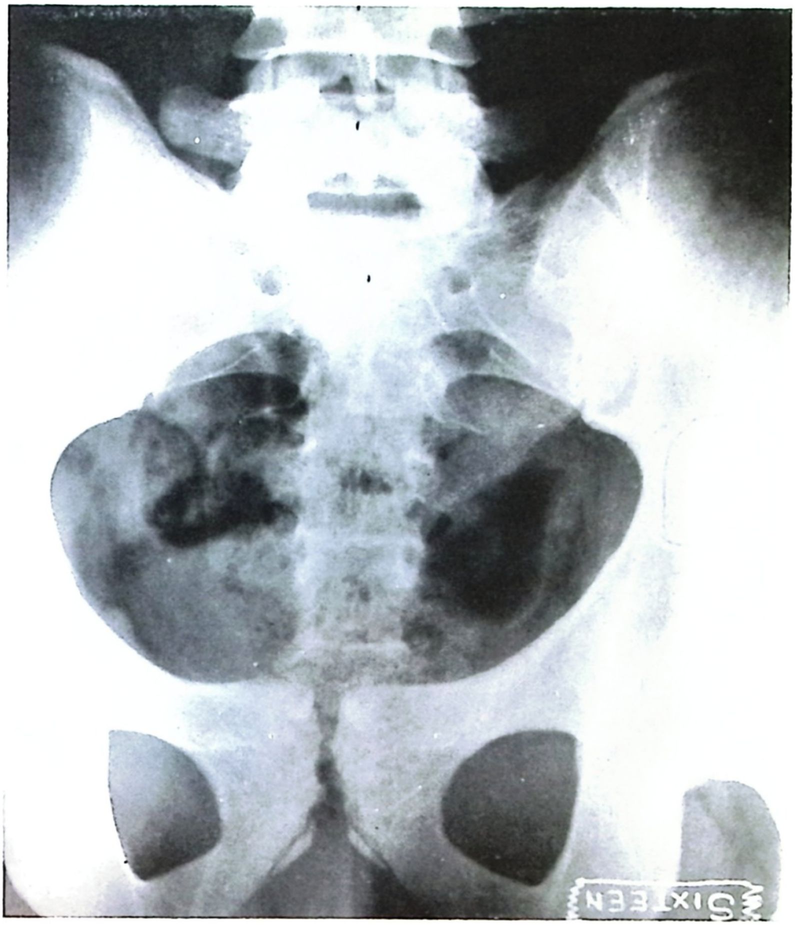


Figure No. 71a

SACRUM AND COCCYX — AP View

Sectional 8x10
Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	79	7 sec.	30″
100	66	3 sec.	60″

Figure No. 72

SACRUM AND COCCYX—Lateral View
(Refer to Chapter 20 for the placement information)

Figure No. 72a

SACRUM AND COCCYX — Lateral View

Sectional 8x10

Technique

Extra Speed Screens

Buck (Red Label) Film

With Bucky

M.A.	KVP	Time	Tube Dist.
25	85	7 sec.	30″
100	72	4¼ sec.	60″

REFER TO CHAPTER NO. 20

FOR DORSAL CERVICAL PLACEMENT

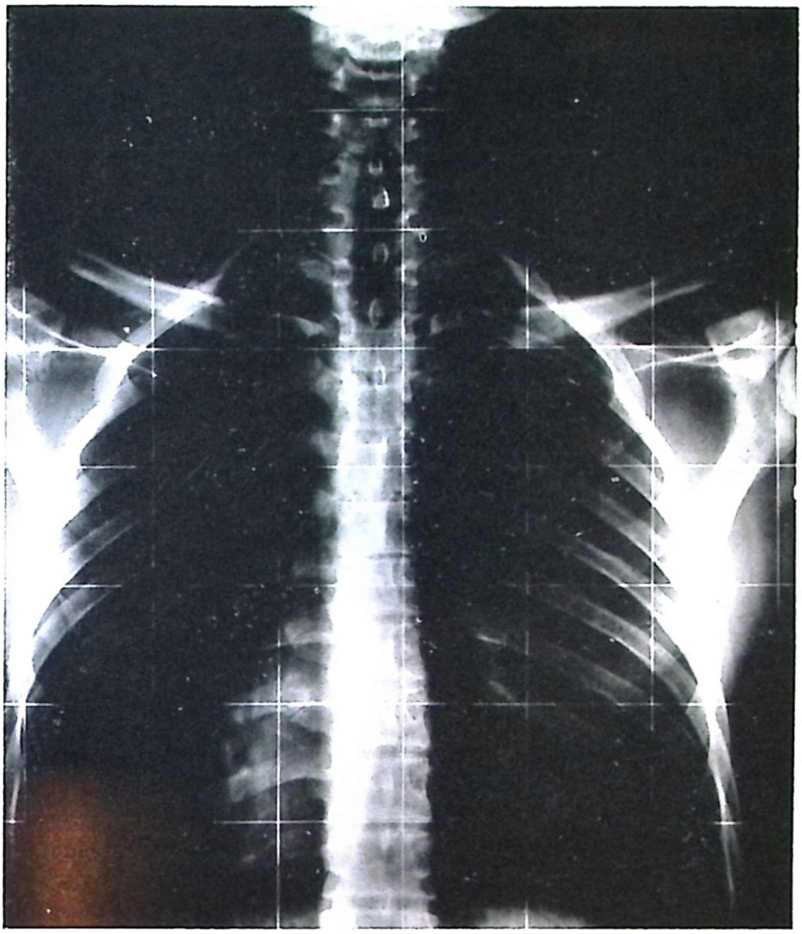


Figure No. 73

DORSAL-CERVICAL AP View (14x17)

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	68	4 sec.	48″
100	68	$2\frac{3}{4}$ sec.	60″

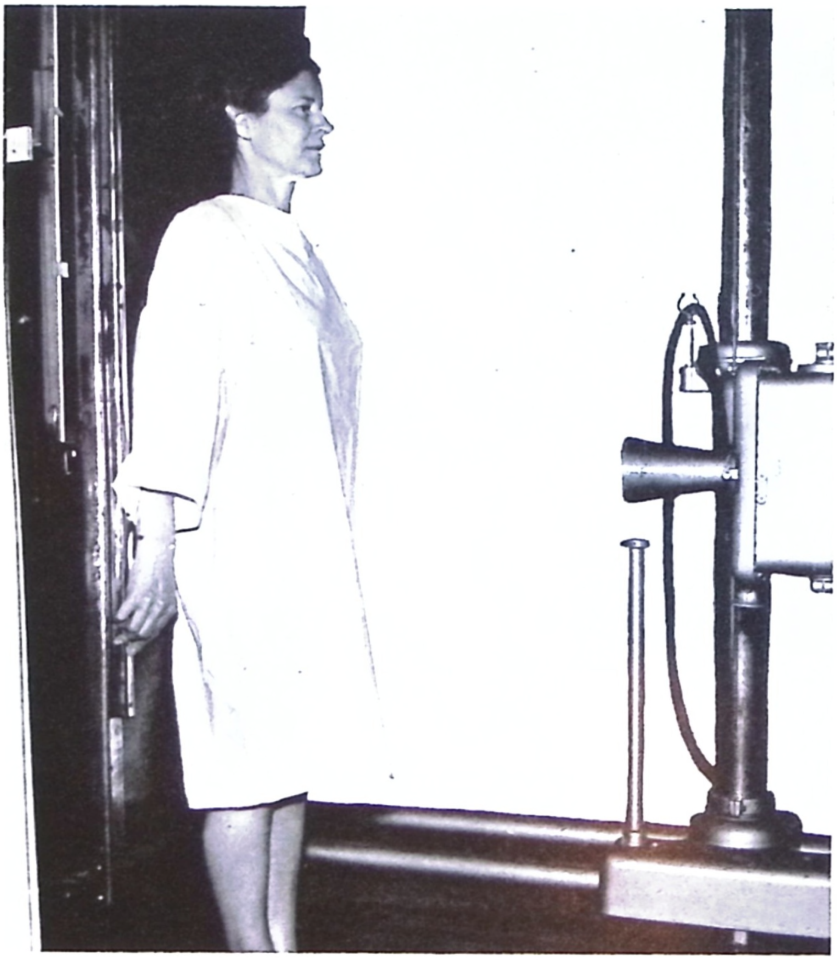


Figure No. 74

LUMBO PELVIS
AP View—14x17
(Refer to Chapter 20 for the placement information)

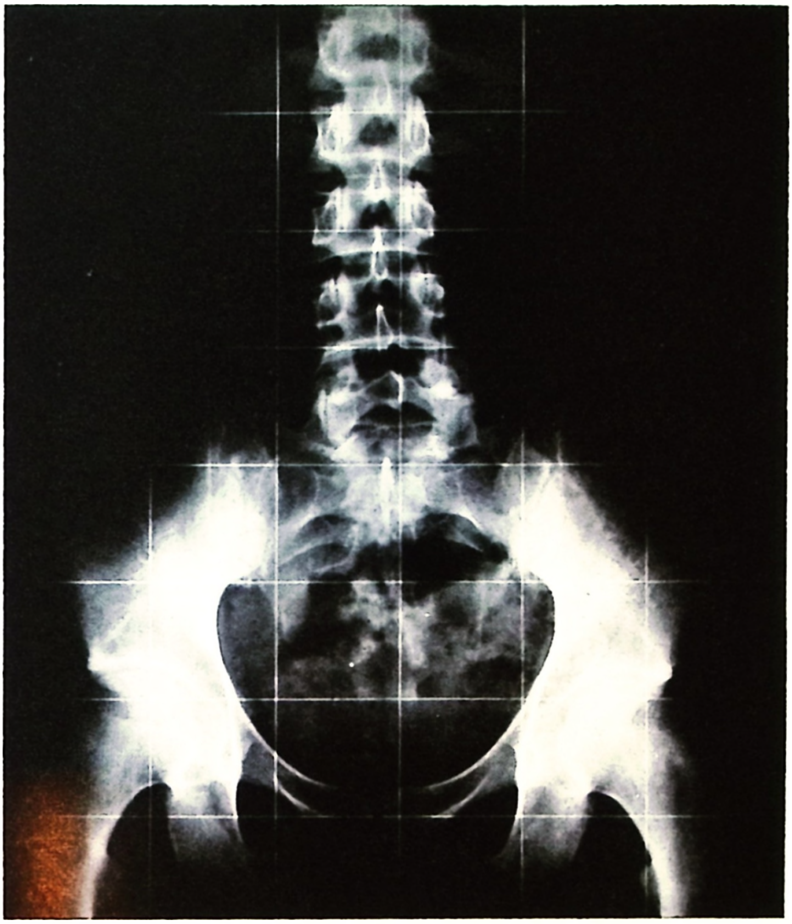


Figure No. 74a

LUMBO PELVIS Including Coccyx
AP View 14x17

Technique
Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	75-80	5 to 6 sec.	48″
100	70	3¾ sec.	60″

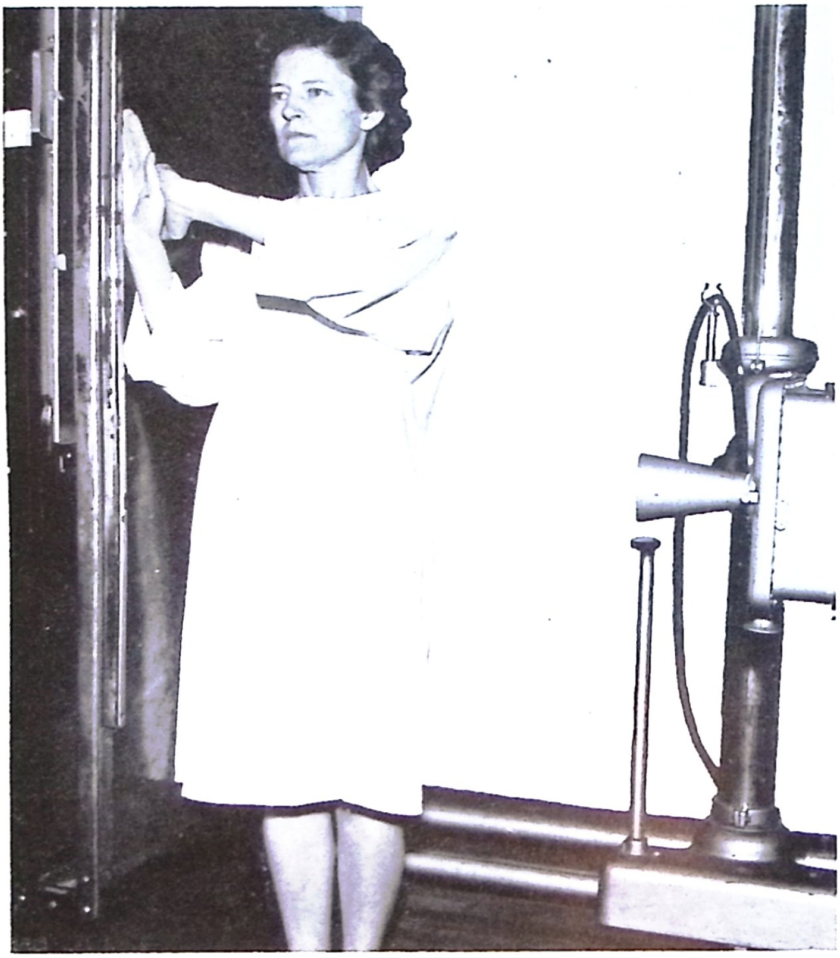


Figure No. 75

LUMBO PELVIS
Lateral View—14x17
(Refer to Chapter 20 for the placement information)

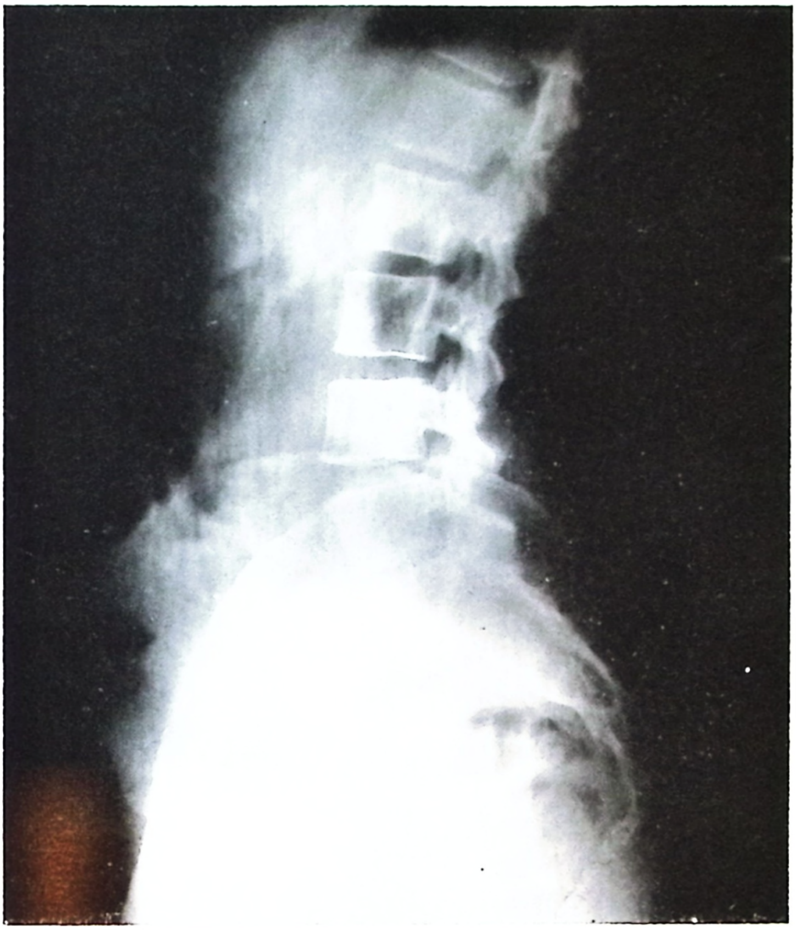


Figure No. 75a

LUMBO PELVIS Including Coccyx
Lateral View 14x17

Technique
Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube Dist.
25	80	8 to 9 sec.	48″
100	80	5 to 5½ sec.	60″

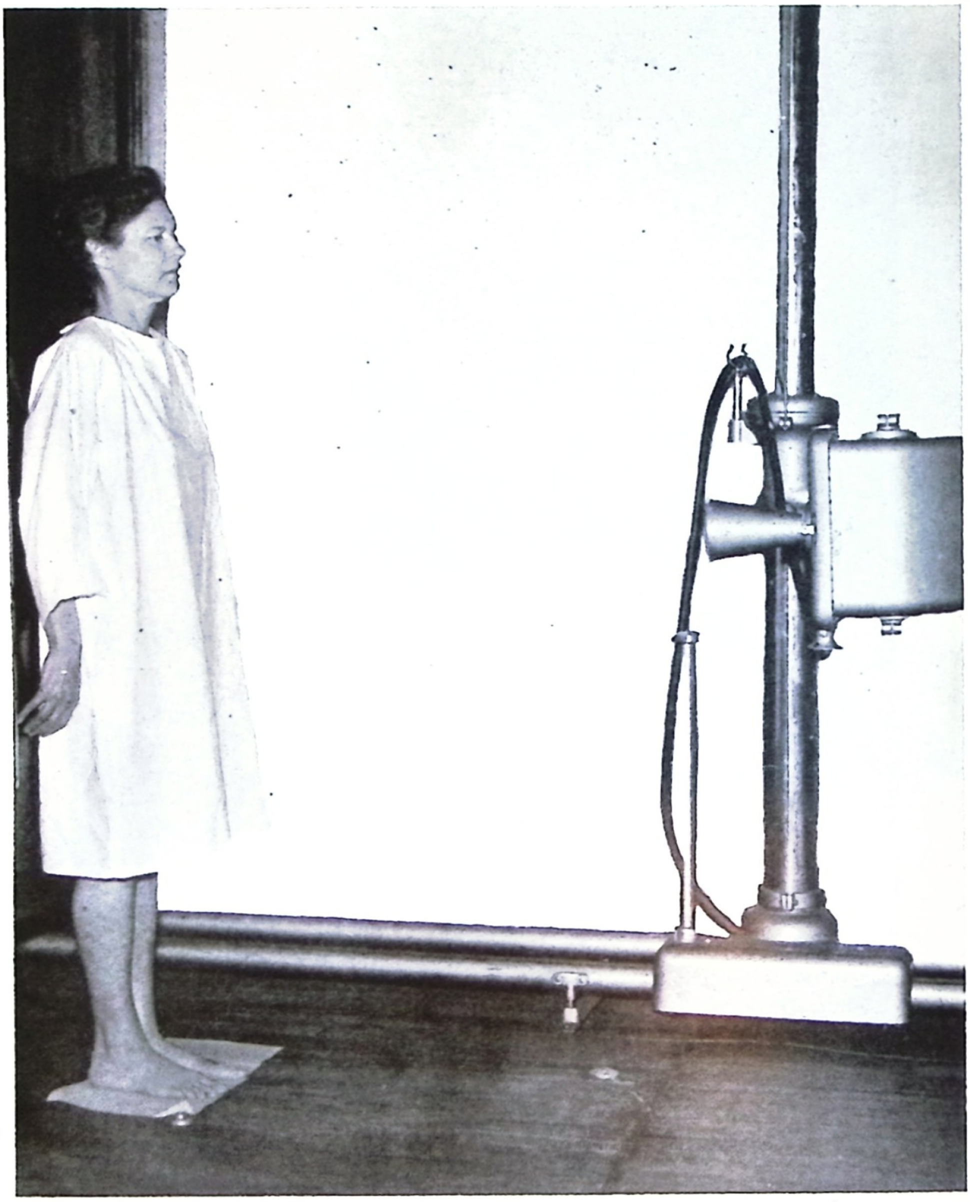


Figure No. 76

FULL SPINE 14x36, AP View, Standing
(Refer to Chapter 20 for the placement information)

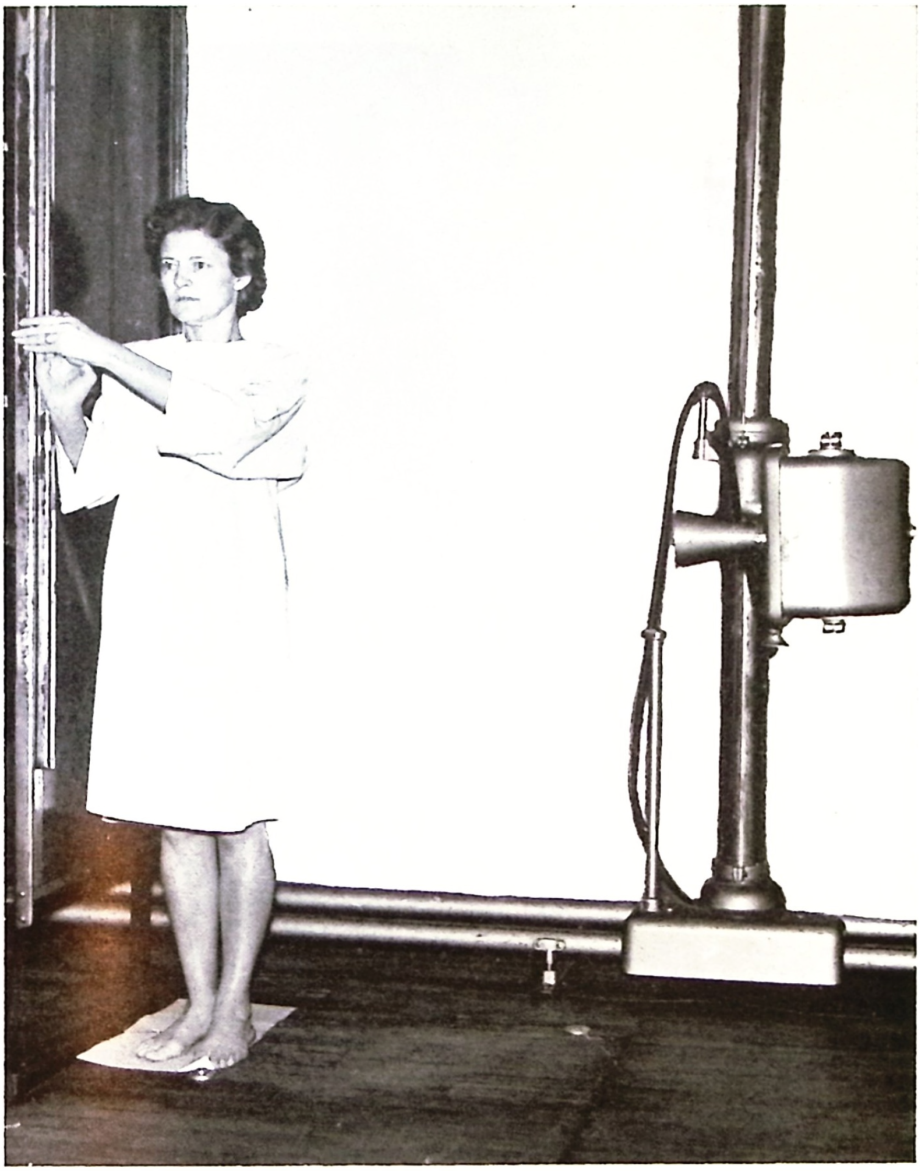


Figure No. 77

FULL SPINE 14x36 Lateral View, Standing
(Refer to Chapter 20 for the placement information)

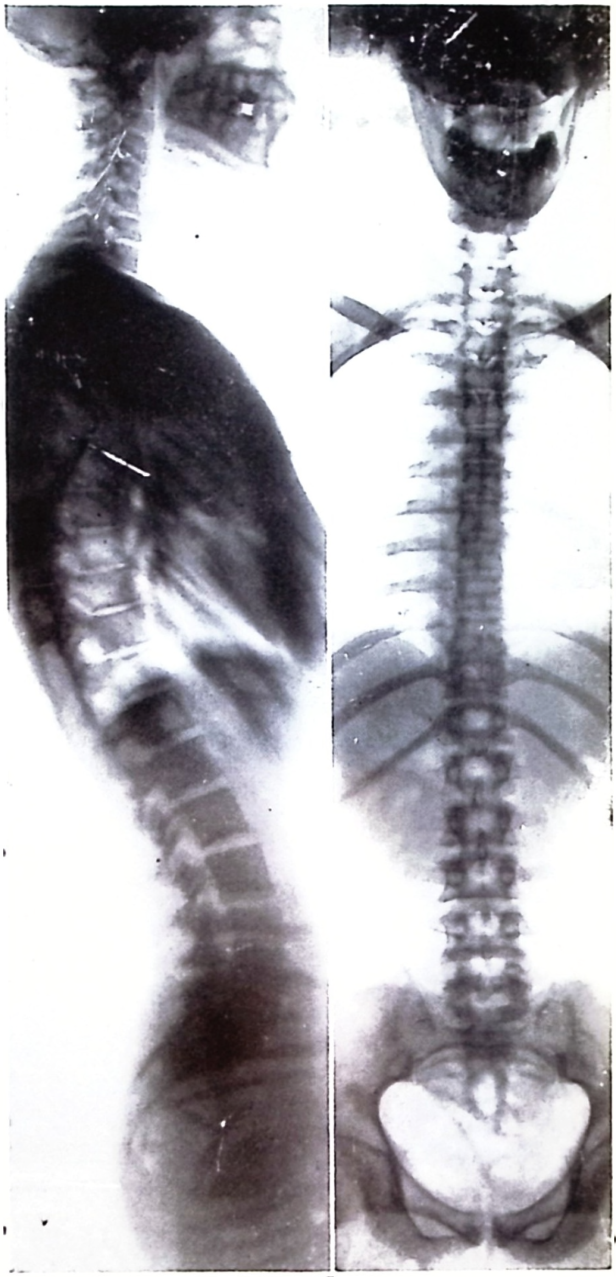


Figure No. 78

FULL SPINE
Lateral View 14x36

Technique

Extra Speed Screens
Buck (Red Label) Film
With Bucky

M.A.	KVP	Time	Tube D.
25	85	12 sec.	48″
100	80	5 sec.	60″

FULL SPINE
AP View 14x36

25	85	9 sec.	48″
100	72	3¼ sec.	60″

(Refer to Chapter 20 for the placement information)

CHAPTER 25

Methods of Improving Technique

One of the most constant and persistent problems confronting the average chiropractor in spinographing patients is arriving at a workable solution by which he can consistently get good radiographic views of all his patients. The writer believes that in X-raying the spine—particularly the upper cervical region—there is a greater variation in machine technicalities necessary than in any other type of radiography. To get pictures in which you can differentiate between tissue in fractional differences in depth—which is absolutely necessary from an analytical standpoint—requires not only a more intimate study of gross anatomy relative to density from a standpoint of penetration, but also a knowledge of the relative density of osseous tissue in the various ages as well as size and weight.

In discussing ways and means of improving a technical procedure it is necessary first to know what is wrong with a film. When examining a developed film it should not be difficult for the spinographer to determine whether it is satisfactory or not; but it might be difficult to tell exactly what has been at fault in making the film.

The manufacturers of developers recommend developing films from three to six minutes. This requires a film to be properly exposed.

If the technique was calculated too heavy, the film would

be over-exposed or too dark. This usually means the exposure time must be reduced and, perhaps, the kilovolt peak. Always use the least amount of K.V.P. possible, for this cuts down secondary fog. When the film develops too light, add time, or current, or both.

It is a common opinion that a rather small room with a suitable safe-light is sufficient for a darkroom. And it is, providing there is no outside light leaking in from the corners or around the door. In many darkrooms, shortly after the lights are turned out, the author has detected a shaft of light coming in from over the door, or through a nail hole; or from some other crack or crevice which the operator had not considered important. Yet, some of those same individuals who get poor films remark that at night they can develop the films and get better results than during the day. So be absolutely sure that all actinic rays are excluded. And use a safe-light that is safe.

Taking for granted that the developing procedure is carried out correctly, observation of the developing film is the best means of determining just what is wrong with your machine technique in making X-rays. Some technicians use an alarm clock to know when the three or six minutes developing time is up. Others observe the film during the developing process and develop by color. Very much information concerning proper machine technicalities in the production of spinographs can be ascertained during the developing process. Many factors are considered:

Over-Penetration—During the early developing of an over-penetrated film you will notice a muddy appearance of the entire film. A muddy appearance is mainly secondary fog. At no time is there a black and white contrast, as the rays have penetrated almost the entire structure to the same degree. Such a film must be removed from the developer at a very early stage in the developing process to be readable.

Under-Penetration—This means there is insufficient penetration to show definition. In that event soft tissue offers resistance to the rays almost to the same degree as the

bony structure. Such a film, in the early developing stage, would appear very light with little outline even of the image itself. And if left in more than five minutes, the film will still be lacking in detail, contrast, and differentiation of structure, and it will be of little value.

Over-Exposure—The film over-exposed, in early developing stage, appears black and white, with the white rapidly turning to a darker color. This destroys minute structural depth differentiation. Such a film must not develop the full time, but should be removed from the developing solution before it becomes too dark.

Under-Exposure—An under-exposed film, in the early developing process, appears more or less black and white but does not continue to develop sufficiently to facilitate definition. Like under penetration, this film is of little value.

A properly penetrated and exposed film should develop full time. The last minute of developing brings out the detail and contrast. It should be the aim of every technician to arrive at a technique whereby the film will develop in the regular time.

Handling of films and cassettes—Must be done in a careful manner, and by film edges only. Do not drag film over edge of cassette. Rough handling of film causes static lines, cracks and abrasions. Finger marks will be visible on the negative. Also handle cassettes carefully, for they get out of shape quite easily. Keep screens clean and free from dust particles; otherwise the negative will reveal small white specks.

Temperature—films should be processed at 68 degrees Fahrenheit and developed full time. Solution that is too warm softens the emulsion. Submerge films quickly and agitate. This prevents air bubbles forming on the negative. Air bubbles result in film blisters. Both rinse and wash tanks must be kept free from rust and corrosion. Rinsing films in clear water after developing stops development and prevents contaminating the hypo. Film hangers must be

kept clean (free from corrosion), so it will not ruin the developer and hangers.

Storage—Undeveloped films must remain in the black paper and in their original box. Keep them in a lead-lined cabinet. X-rays, secondary or even static electricity will fog films unless they are protected in this manner.

Washing—Is very important. This process requires constantly running water. Temperatures of both rinse and wash water may range from 50 to 80 degrees Fahrenheit. Should the wash water be warmer and the hypo not up to par strength, 30 minutes of washing might cause the emulsion to slip from its base.

Remember—the spinograph begins and ends in the darkroom.

CHAPTER 26

Introduction to Spinal Analysis

Figure No. 9 is a working chart showing how the spinal column has been classified and divided into digits. Thus this exemplary model reveals what must be considered to correctly determine the vertebral listings. This is particularly true in atlas axis analysis, although it applies in many ways to the entire spinal column. It proves certain things to be correct and discounts others. Each factor plays an important part.

Before continuing, I should like to call attention to the fact that any spinal X-ray letter listing is a misalignment —an external segmental measurement. It does not mean it is producing vertebral interference to mental impulses. Therefore, it does not imply it is a subluxation. However, a subluxation is a vertebral misalignment. Often it is assumed the misalignment produces interference; and to adjust promiscuously simply because the vertebra measures out of alignment may defeat the real objective. Regardless of a letter listing, do not adjust until you know interference exists. And if it does, in all probability it is the result of a misalignment. But it could be otherwise. Innate intelligence and interference and adaptation are the basis for this work. Mechanical ability is the talent you must possess and apply.

Distortion means a change of contour or magnification. It is prevalent in all radiographs. Refer to Figure Nos. 14

and 15—which represent the target of the X-ray tube, the direct and angling radiation. A point directly below the focal point is the only spot on the film said to be free from distortion. As the rays increase in their angle this perversion of relationship becomes exaggerated. When it only increases the size of the object, it doesn't materially interfere with the procedure of reading the spinograph, except for a lack of contrast and definition. But when it produces elongation—and particularly when it changes the lateral contour of the vertebra—it causes errors in the analysis. Even to X-ray vertebrae in the anatomical position, would make for some degree of distortion. Now consider the misalignment in relation to the angling radiation: the distortion increases. It is again exaggerated by anomalies and some degree of malposition which is usually present. Precision methods will eliminate the malposition, naturally reducing the degree of distortion; but the anomalies must be compensated for by visualizing the normal through the abnormal when working out the analysis.

Anomalies and malformations are synonymous and refer to the non-proportionate parts of a vertebra. The skull, larger on one side than the other, curvatures, or leg deficiency—all interfere when making correct placement. Variations in the condyles, the occiput, as well as other variables through the spine, often make the analysis difficult to obtain, and some degree of compensation must be made.

Malposition refers to the patient being improperly placed. The patient may be laterally off center right or left, there may be lateral posterior or anterior tipping, or possibly, head or body rotation. While some degree of accuracy can be assumed when compensating for the variables, it is always wise to retake the view, if possible.

X-ray exposure naturally plays an important part. Descriptive parts must be clearly readable because one part is compared with another. When they are not visible it is virtually impossible to read the film. The patient's age, weight, occupation, tissue thickness and physical condi-

tion must be very carefully considered to arrive at the correct technique.

Analysis is obtained by external comparison of the descriptive parts. This determines the directions in the misalignment, and such factors as the stance, contact, line of drive, and torque.

Speaking of lines of drive, there are several ways by which they are determined. Such devices as protractors and plumb bobs, etc., are used. The Lin-O-Drive is another device. It seems scientific, professional and practical. A simple adjustment of the pointer rod (see Fig. No. 8) determines the stance.

To use this instrument for analysis it is my opinion that three additional lines should be drawn on the regular A to P spinograph: one line to represent the angle of condyle; another for the angle of the superior axis articulation on that side, and then a horizontal line midway between these two angles and at right angles to the median line. The angle of drive is determined from this line.

Determine the amount of atlas rotation from the base posterior view. Tilt the rod forward for the superior drive, and laterally for the anterior drive. This should give the chiropractor an idea of his superior stance, and how much lean-over is necessary, if any, over the patient in the chiropractor's line of drive.

As previously stated, our opinion is that spinographs of the entire spinal column should consist of at least three 8 x 10 cervical views: the Lateral, A to P regular or natural and the base posterior or vertex, preferably the base posterior; then the two 14 x 17 films from the axis down through the pubic bones. When further information concerning the upper cervical is needed, take a nasium or stereo. The nasium will not suffice for the regular anterior posterior view, but it is another view from a different angle. If additional views are needed of the lower back, take either the lateral dorsal or pelvis. As a matter of fact, it is always a good plan to take a lateral view centered on the 5th lumbar when it is seen tipped forward, because

there may be some degree of spondylolisthesis. It could be very injurious and dangerous to the patient to attempt to adjust the 4th or 5th lumbar not knowing that either were dislocated. Such things bring on malpractice proceedings.

At this point some terms and phraseology used in the analysis should be explained.

Letter listings refer to the directions in the misalignment, such as "A" for anteriority, "S" or "I" for superiority or inferiority, "L" and "R" for laterality. Rotation is written, left trans. Ant or Post or vice versa.

Border-line means the directions in the misalignment are minute. It does not imply the seriousness of a case.

Plus sign (+) indicates one direction in the misalignment is greater than another.

Fusing and welding refers to ankylosis.

Cleft or incompleteness means two component parts have not ossified.

Rotation means a twist.

Rocked or rocking refers to the ilium tipping backward.

Compensation means to judge the present positions or directions of the misalignment through all the variables.

The point system refers to a method of reading the atlas and axis using only the lateral and the posterior anterior or nasium views. Here one descriptive part is compared with another—so many points for and against; then subtract or make deductions. This is more or less guesswork: first, because of the variables; and second, because of a lack of views for verification. Incidentally, there are no concrete points to prove atlas laterality using only the regular A to P view. All such possible points also indicate atlas rotation, etc. It actually takes the base posterior or vertex, together with the regular A to P to prove atlas rotation and laterality.

Atlas-axis comparison is a simple idea to prove atlas

rotation and atlas condyle laterality. The rotation of atlas is proved by the base posterior view: the body of axis is compared with the median line on the A to P regular spinograph and the atlas compared with the axis on the base posterior view. Then final deductions made. The degree of accuracy is very high. Not being able to determine or locate certain points—due to variables in these few cases —keeps the method from being 100 per cent accurate.

The axis is always read first because it is the basis for all upper cervical measurements. Next, atlas rotation; then atlas laterality, etc. When reading the spine below axis, begin at the 1st, 12th dorsal or 5th lumbar, as the case may be. Then read the lower portion of the spinal column.

Illuminators

The laboratory should possess a stereoscope which will accommodate at least an 8 x 10 film, for there are occasions when more depth or third dimension is desired. For instance, the doctor may wish to examine for possible spinal fracture or dislocation, or a particular intervertebral foramen for exostosis, the fovea dentalis or any articulation for ankylosis, the pituitary, cervical or some other gland for calcification—even the gall bladder or kidney tract for stones. Many times the regular flat film will not disclose the actual condition, and in the course of chiropractic service it may be absolutely necessary that other areas and conditions be investigated by the use of stereoscopic views.

Further, an 8 x 10, 14 x 17—perhaps a 14 x 36—viewing box with opal blue glass and a rheostat should be employed. Rheostats are necessary to change the light intensity to suit the film. A dense film demands more light, while the less dense requires less illumination. Fluorescent lighting will not suffice for this purpose.

The 8 x 10 reading box is more convenient if it has three compartments to allow for three cervical views, or even three sectional views, to be seen and read at the same time. This avoids back-tracking throughout the procedure, and it expedites the work.

CHAPTER 27

Steps in the Analysis

More accurate analysis and better results on patients are obtained when all three cervical views are observed at the same time. To do this requires a three compartment reading box. With film markers seen at your right side, look for anomalies and malposition. Remember this all through the process of analysis. These variables cause errors when listing the spinograph—and many more errors may be committed when these factors are ignored.

It is usually wise to retake a case when improper positioning of the patient exists. However, malposition may be compensated for during the analysis to some degree of accuracy. In other words, make every effort to see the normal through the abnormal—and to know the true relation of one part with another when placement is seen improper and incorrect.

To avoid confusion and obtain the maximum results in the shortest possible time, a system or method should be followed when reading the spinograph. Step-by-step method, and a system of handling one's working tools is proposed here. It works very satisfactorily.

On the AP REGULAR CERVICAL VIEW—(1) Mark the center of the odontoid at its base (AP view). This indicates the center of the body from a posterior aspect. Then mark the junction of the laminae. However, this junction is not always visible. Usually a light line is seen

extending from the tip of the spinous process to or toward this junction. When the junction is not visible, mark this line as near to the junction as possible.

On the BASE POSTERIOR CERVICAL VIEW—(2) Now mark the lateral center of the basilar process.

On the AP REGULAR CERVICAL VIEW—(3) Bisect the distance between the medial inferior points of each condyle (AP view).

(4) Then mark the center of each transversarium foramen (BP view).

On the LATERAL CERVICAL VIEW—(4) Draw line through atlas (lateral view) from the darker area of the anterior arch back through the center of the lamina.

On the AP REGULAR CERVICAL VIEW—(5) Draw basic line through orbits level with the skull (AP view).

(6) Draw the median line down at right angles to the basic line through point of bisection (AP view).

(7) Draw wedge lines (AP view)—top line from jugular to jugular and the lower line from a lateral inferior point of one lateral mass to the same point of the opposite lateral mass.

On the BASE POSTERIOR CERVICAL VIEW—(8) Draw line through center of each transversarium foramen.

(9) Draw line from the top of the nasal spine down through center of the basilar process (BP view). This line may or may not line up with the external occipital protuberance. If it doesn't line up, the reason would be an anomaly of the external occipital protuberance, tilt or rotation of the head. Always consider the variables when drawing this line.

(10) Now measure with dividers or compass from the center of the odontoid (at its base) to the center of the right transversarium foramen. Transfer this measurement to the left side and mark with short curved line. If curved line is right of the center of the left foramen, the atlas is left of axis. When curved line is left of the center of left foramen, the atlas is right of axis.

On the LATERAL CERVICAL VIEW—(11) List axis, atlas, curvature, exostosis, ankylosis, etc., (lateral view).

On the AP REGULAR CERVICAL VIEW—(12) List spinous of axis in relation to its body and the body in relation to the median line (AP view).

(13) When reading the AP natural without a base posterior or vertex list the rotation of atlas by comparing the descriptive parts with one another (point system). Then list the laterality. The first indication would be the point of wedge. Usually when the atlas moves laterally it raises up on the condyles (this makes the point of wedge), and the tendency would be to rotate anterior on that side. So the second indication of sideslip would be the lateral tilt.

These indications must then be checked with anomalies, spaces and malposition before definite conclusions are reached. As stated previously, the point wedge is only an indication of the lateral atlas. We find many left atlases in right point wedges—and right atlases in left point wedges.

When reading the AP natural with the base posterior or vertex, list only the axis and the point wedge on the AP natural view. The rotation is determined and proved by the base posterior, etc.

On the BASE POSTERIOR CERVICAL VIEW—(14) Now read atlas rotation (base posterior view). When the atlas line and the perpendicular are at right angles, regardless of any lateral head tilt, the atlas is not considered rotated. However, this is not a common situation. If the relation of these two lines is less than 90 degrees, the atlas is listed anterior in rotation, more than 90 degrees, posterior in rotation. The anterior-rotated atlas tends to appear high on that side; the posterior rotated atlas, low on that side. However, an atlas may be high on that side, yet more than 90 degrees from the perpendicular. The reason would be lateral head tilt high on that side. Always determine the rotation of atlas by comparing the atlas line with the perpendicular (base posterior view).

On the AP REGULAR AND BASE POSTERIOR CERVICAL VIEWS—(15) Compare atlas and axis to determine atlas condyle laterality. First, note the position of atlas either right or left of axis (base posterior view); then the distance between curved line and the center of the left transversarium foramen (base posterior view). Now compare this distance with the distance between the median line and the center of the body of axis (AP view). Then make final deductions.

For instance, if atlas is ¼ inch left of axis (base posterior view), and axis is in the median line (AP natural view), the atlas would be left on the condyles. Or if atlas and axis are measured in lateral alignment (base posterior view) and axis is ¼ inch left of the median line (AP natural view), the atlas would be left on the condyles. Or if atlas were ¼ inch left of axis (base posterior view) and axis ⅛ inch right of the median line (AP natural view), the atlas would be considered left on condyles. Remember always to consider anomalies and malpositions when determining the analysis.

At this point I should like to discuss condyle listings. I have analyzed more than a million films, and in all my experience I have never seen definite evidence of condyle misalignment.

Repeating: Left head rotation means that the face turns towards the left and the atlas tends to rotate posterior, left side. The external occipital protuberance moves towards the right side. Vice versa when head rotates right.When the head tilts or leans low on the left, the atlas tilts with it, etc. As the chin is lowered the posterior arch raises; and when the chin is elevated, the posterior arch lowers.

Full Spine—(sectional views)

Lower cervical and upper dorsal (L.C. and U.D.)

1. Place film properly in the illuminator.
2. Determine landmark (first dorsal).
3. Check for anomaly, pathology and malposition.
4. Locate and mark the junction of laminae. If not vis-

ible, place mark near the junction on light line that extends from the superior tip of the spinous process to the junction to determine the rotated vertebrae. Use the tip of the spinous process when other points are not visible.

5. Determine curvatures (plain scoliosis, rotatory scoliosis or just rotation) of 3 or more adjacent vertebrae rotated in the same direction.

6. Compare the junction of laminae or the superior tip of the spinous process in question with the one above and the one below.

NOTE: A vertebra cannot be listed right unless it is rotated left and right of the one above and below. In other words, the one listed right must be rotated more than the one above and the one below. When referring to laterality below atlas, reference is made to the spinous process. If the body of the vertebra has moved right or left, such inference is specifically made.

7. Determine superiority or inferiority. This indicates lateral tilt.

Lower dorsal (L.D.)

1. Same as above.
2. Determine landmark (12th dorsal).
3. Check for anomaly, pathology and malposition.
4. Locate and mark the junction of laminae or at a point on the light line (ridge of spinous process) that extends from the tip of the spinous to the junction of laminae, to determine rotation.
5. Determine curvature.
6. Compare junction of laminae with the one above and below.
7. Determine superiority or inferiority.

Lumbar

1. Same as above.
2. Determine landmark (5th lumbar and second tubercle of the sacrum). All other steps are the same as above.

Sacrum and coccyx

1. Same as above.

2. Determine landmark (2nd tubercle of sacrum).
3. Check for anomaly, pathology and malposition.
4. Determine rotated sacrum.
5. Determine laterally bent coccyx.

Full spine column (2—14x17 films)

Cervical dorsal (below axis)

The reading is conducted in the same manner as the sectional views, except that both landmarks are located and marked on the same film. Ribs should be carefully checked to verify the vertebral count. Also, there are 11 and 13 pairs occasionally found, and a short rib is rarely found attached to the 7th cervical. Very seldom is there a cervical rib attached to both sides of the 7th cervical. Certain conditions of the chest may be indicated in this spinograph. However, it is not considered a chest film.

Lumbar Pelvis

The procedure throughout the lumbar is same as the lumbo 8 x 10 section. Landmarks are the 12th dorsal, 5th lumbar and the second tubercle of the sacrum. Occasionally the kidneys and the gall bladder are visible on this film.

Pelvis lumbar

1. Ordinarily the 14-inch width is sufficient to include all of the greater trochanter on either side. Naturally, this reveals both acetabula. There are times, however, when this width is not great enough, which means the length of the film must be placed horizontally instead of perpendicular. In this event the 8 x 10 lumbar section is included with the two 14 x 17 films to obtain the entire spinal column. Though the marker is seen on the right side, it should be in the soft tissue area so as not to interfere with line drawing or reading the ilium.

2. Check the 5th lumbar and sacrum for rotation, and at the same time compare the 5th lumbar with the 4th and 2nd tubercle cf the sacrum.

3. Examine coccyx for laterality.

4. Check for leg deficiency.
5. Check for any superiority of the ilium.
6. Determine any rotation or rocking of the ilium.

NOTE—A lateral view is necessary to determine the anterior bent coccyx and the anterior dislocated 4th and 5th lumbar.

CHAPTER 28

Line Drawing

Plane lines are essential and must be accurately drawn on the spinograph to avoid mistakes in the analysis. This is particularly true when listing atlas and axis and lower back. These lines should be thin but clearly visible. A Noblot ink pencil No. 705 seems to be the type to use. Incidentally, the 18 inch transparent flexible ruler, 2 inches wide is ideal for line drawing. Other necessary tools are a large magnifying glass, a 4x6 triangle, a 6 inch transparent protractor and a good compass (one that supports a pencil). All these may be obtained at the PSC Sales Room or most any office equipment store. Repeating—plane lines must be carefully and accurately drawn.

Lateral cervical film

1. Draw line through darkened area of the anterior tubercle of atlas back through the center of the lamina of the posterior arch. This line is compared with an imaginary horizontal line through the center of the same darkened area. This determines the superior and inferior atlas. The anatomical angle is approximately 8 degrees upward toward the anterior. Anything over 8 degrees would be superior; less, inferior. So a level atlas is inferior. This is the only line drawn on the lateral cervical film.

A to P regular cervical film

1. Locate and draw line from one jugular process through

the other; then draw another line from the lateral inferior point of one lateral mass through the same point of the opposite lateral mass. These are called wedge lines. Where the two become closer together is called the point wedge, the other end the blunt of the wedge. Throughout the information written on the analysis, reference is frequently made to the point and blunt of the wedge.

2. Repeating, locate and mark the inferior medial points of each condyle, then bisect and mark this distance which indicates the center of the foramen magnum or point of bisection. When locating these points of condyles always consider the arc which represents the anterior portion of the foramen magnum, and the two light lines usually seen extending diagonally upward from each side of this arc. The arc is the half circle seen over the odontoid of axis—and the diagonal lines are the lateral margin of the posterior half of the foramen magnum. All three of these points unite into one on either side and it is from these points the center of the foramen magnum is considered.

3. Now a basic line is drawn horizontally across film through the lower orbit area at right angles or level to the skull. There seems to be no concrete points from which to draw this line that will consistently keep it at right angles. However, begin by placing the ruler at a point where the diagonal light line within these orbits extends from a lower margin upward to the lateral rim of these cavities. This light line is a ridge caused by the joining of the sphenoid and zygomatic bones. When the ruler, at these points, is not at right angles then raise or lower one end until by using other points it becomes level or at right angles to the skull.

4. The triangle is now placed against the basic line and the point of bisection, then draw the perpendicular or median line. This line should always split the foramen magnum but may not divide the skull laterally because the foramen magnum is frequently found off center as much as one-quarter of an inch. For convenience draw a short line to indicate the junction of laminae of axis and another

short line to indicate the center of the base of the odontoid.

Base posterior (BP) or vertex

1. Repeating—locate and mark the center of each transversarium foramen. Draw line from one to the other.

2. Then a perpendicular line is drawn down from the tip of the nasal spine to the external occipital protuberance. If there is no head rotation in placement or anomaly of the protuberance, this line should divide the basilar process. The basilar process is possibly more consistent than the occipital protuberance.

3. Next use the compass at the lower center of the odontoid to the center of the right foramen. Always the right foramen first. Flip dividers over keeping contact with the odontoid and scribe a short curved line on the left.

Note: Lines are not drawn on the oblique or diagonal views.

It is not necessary to draw lines on the sectional or cervical full dorsal views. However, it is no crime to draw lines from the junction of the laminae of one vertebra to the same points of the vertebrae above and below. This gives the line drawing a jagged or denticulated appearance. Some believe they can recognize the more rotated vertbra in this manner.

Pelvis Lumbar—14x17 film. This view requires several lines to accurately read the various misalignments which consist of five types and their combinations.

Leg deficiency—usually adaptative.

Rotated sacrum (with or without lateral tilt). Lines are not used to determine the rotated sacrum.A simple way is to measure from the second tubercle of the sacrum to the sacro iliac articulation. The greatest distance indicates the posterior side of the rotation.

Rocked ilium (usually towards the posterior). This means the posterior superior spine on that side moves inferior.

Rotated ilium or innominate—(internally or externally). Internally means the posterior superior spine moves laterally away from its sacro iliac articulation at the posterior

as the innominate rotates. Externally means just the opposite—in other words, the anterior portion of this segment swings out laterally, tending to move the posterior superior spine closer to the median line, at the posterior. The rotation of the innominate (hip bone) causes the descriptive parts to appear wider or narrower in relation to the opposite side.

Superior ilium—refers to the relation of its sacro iliac articulation with no reference to the opposite side. A superior ilium is not a common misalignment.

1. Draw a line from the very top of the head of one femur to the same point on the opposite side. If this line is horizontally level, so are the heads of both femurs. If not, then draw another line from this point of the highest femur horizontally or level across film. These two lines make a wedge: The point indicates the short leg; and the blunt of the wedge (the end in which these two lines are farther apart) indicates the long or deficient leg. Incidentally, cassettes used for this work or for the spinal column below axis, should include intensifying screens with ruled lines making two inch meshes. Such rulings are advantageous in line drawing.

2. Next, draw a perpendicular line from the center of the pubic arch up through the center of the second tubercle of the sacrum to about the second lumbar.

3. Then four short lines are drawn: Two, one on either side from the superior crest of the ilium at right angles to the perpendicular; and two lines from a superior point of each head of femur to the perpendicular. This makes a total of four short lines: Two above (top) and two below (bottom).

If the top two lines are found to be continuous (in line with one another) and the same is true of the lower two lines, the ilium would not be superior. There would be no leg deficiency or rocked ilium, at least to any degree. In that event there may or may not be a rotated sacrum or innominate bone. When the distance between the top two

lines equals the distance between the lower two lines on the same side at the same point in a laterally tilted pelvis, the ilium still would not be considered superior, whether the pubic bones were laterally aligned or not. In all probability there would appear to be leg deficiency.

If the pubic bone on that side were lower than the opposite side, it would further substantiate leg deficiency on that side.

If wedge lines were present and the pubic bones were laterally aligned—or even one higher than the other on the side of the blunt of wedge—and the distance between the top two short lines equalled the distance between the lower two lines, all on the same side, the indication would be an inferior posterior superior spine in leg deficiency. If the distance between the top two lines equals the distance between the lower two lines on the same side, with the sacrum or pelvis generally level, the ilium on that side would be considered superior. Further indications would be in the observance of the inferior sacro iliac articulation, and where the ilium meets the top side of the sacrum on that side.

Should there be greater distance between the top two lines than between the lower two lines—or even with the lower lines continuous—the probability is there would be no leg deficiency, but an anomaly.

The writer could go on and on with all the combinations; but the above are the most important.

CHAPTER 29

Interpretation of the Procedures in the Analysis

Mechanical ability and the perception thereof is vitally necessary in both the reading and to perform the adjustment. It means the difference between chiropractic success and failure. Rules and methods in film analysis are high in accuracy; however, because of the need to consider variables, experience is very often required when making a final decision. To read the spinograph correctly is one thing; to know how to adjust the vertebra correctly is another. It is important to know that letter listings mean little until one realizes how the vertebra moved or misaligned itself to that position. Therefore, each case is individual. The procedure in listing and correcting the misaligned atlas or axis is more difficult than any other segment of the spine. This is because of their structures and the particular manner in which they misalign themselves.

The writer would like to state that if the competent analyst would include contacts and lines of drive, torque, etc., in his report and then, if the field chiropractor would follow through to the very best of his ability, better results would be obtained.

The axis is a symbol of strength and support. It is peculiar and the second spinal vertebra. It is actually larger

than the atlas though its neural ring is smaller. The descriptive parts consist of a body, odontoid or dens, two transverse processes including two anterior and two posterior roots, two transversarium foramen (one in each transverse process), two lamina, two pedicles (connects lamina to body), one neural ring, spinous process, two superior articulations and two inferior articular processes known as the post zygopophyses.

The odontoid forms a pivot around which the atlas rotates. Its dens is in such close proximity to the medulla oblongata that interference might be produced directly against that portion of the hind brain. Opinion: axis plays a more significant part in the upper cervical specific than many realize.

The axis moves abnormally in several directions, therefore there are many combinations of directions in the misalignment. The tendency is to rotate with the atlas. However, it is the key to upper cervical measurement in analysis because its misalignment usually changes spaces relative to atlas. Therefore, axis should always be read first when reading the upper cervical spinographs.

Lateral cervical view—(refer to Fig. No. 62a) determines the posterior inferior axis, anteriority (abnormal mobility of atlas straight forward) which is always present to some degree because when it moves out of normal position it first twists, then it naturally swings around to at least some degree laterally—then because the condyles set slightly higher in front than at the back, due to the secondary curve in the neck and also because of the angle or pitch of these articulations—the atlas usually goes to some degree anterior and superior. There are more anterior rotations than posterior—and more superior than inferior atlases. Also this view is more practical in locating fractures, dislocations, abnormality, ankylosis, etc. It also reveals the posterior anterior curvatures.

To determine the posterior inferior axis, compare the alignment of the halves of the intervertebral foramen.

Note the light line that represents the posterior margin of the body of axis. If this line is in continuity with the arc made up of similar lines of the bodies of the cervical vertebrae, the axis is not inferior. If it tips backward the axis would be inferior; and if the intervertebral foramen of axis was posterior to that of the third cervical, the axis would be considered P.I. In that event the zygapophyses of axis and third cervical would not parallel one another—instead would be closer together at the posterior.

Should this light line representing the posterior margin of the body of axis be seen leaning forward, it means the axis has followed the atlas anterior. This anterior tipping of axis is not listed because the atlas would first have to move anterior. By the same token the atlas could not move posterior unless the axis tipped or moved backward. The transverse ligament, odontoid and the anterior arch of atlas are sort of locking devices. The anterior arch limits the axis from tipping or going forward; odontoid to keep the atlas from moving backward and the transverse ligament to keep the axis from tipping or moving posterior. Visible space between the odontoid and the anterior arch might indicate either the PI axis or the anterior atlas or a malformed odontoid (bent posterior). On the other hand an atlas may have gone anterior and no space visible between the anterior arch and the odontoid which means the axis followed the atlas anterior.

AP regular cervical view—(refer to Figure No. 63a). This is the most important view of all cervical spinographs, yet, it does not impart the complete story. It reveals the pivots of axis, indicates the rotation and laterality of atlas, also the lateral tipping of both. This view is also important in seeing malposition, variations of the foramen magnum, condyles, lateral masses, irregularity of the occiput and lateral aspect of the skull, as well as the malformed atlas and axis.

It must be understood that atlas and axis follow the skull, to some degree, in all its range of normal motion—

the atlas moving more than the axis. The condyles with their particular shape and contour act as a guide in the movement of the atlas. When the atlas misaligns it does so in relation to the condyles—and to correct it, it must follow the same path it went out of normal position. From a mechanical standpoint, it would then seem that if the application was applied to the atlas from the anterior, with proper contact, line of drive and torque, all the misaligned directions would begin to eliminate themselves as the rotation was being corrected. Rotation and superiority are certainly major directions.

As previously stated, the axis is listed by pivots, rotation, spinous and body laterality. Whenever mention is made say of a right axis, reference is only made of the spinous process—meaning it is right of its own body, and right of the spinous of the third cervical. Pivots refer to the body and the spinous process with or without laterality.

AXIS LISTING

1st Step—Compare junction of laminae or spinous process with the center of its body. This determines the rotated axis.

2nd Step—Compare the body with the median line. This proves body laterality.

Body Pivot—(refer to Fig. Nos. 81 and 82)

Body rotates and remains in the median line; spinous is seen right or left of its own body. For instance if the body rotates left the spinous will be seen on the right half of the body and right of the median line, from a posterior aspect. Vice-versa when the body rotates right.

Body Pivot with Laterality—(refer to Fig. Nos. 85 and 86)

Opinion: The rotation is first to occur, then the laterality, if any. Say the listing is **axis right, body pivot, entire vertebra left.**

Axis right refers to the junction of laminae or spinous in relation to its body. In this case the junction or spinous would be seen right of the center of its body because the

vertebra rotated left. Just how far right the junction would be in relation to its body would depend upon the degree of body rotation. The relation of the junction of laminae to the median line would depend upon the amount of body laterality as compared with the degree of body rotation. For example: Say the rotation is two degrees left. At this point the junction of laminae would move right of the median line and right of its body. Now following the rotation the entire vertebra is said to have moved, say ¼ of an inch left. The laterality, in this event, would move the junction of laminae left of the median line, but it would remain right of its body.

On the other hand a vertebra may move right even though it had rotated left. The listing would then read **axis right, body pivot, entire vertebra right.** Naturally the junction and spinous would be right of its body and right of the median line. However, the relation of the junction of laminae to the median line would depend upon the relation of the laterality as compared with body rotation.

Spinous Pivot—(refer to Fig. Nos. 89 and 90)

Refers to a low lateral swing of the vertebral body either clockwise or counter-clockwise rather than an actual twist or rotation of the body. Rarely is this swing more than ¼ of an inch—usually it is slight or up to about ⅛ of an inch. The pivot point is in line with the junction of laminae, or nearly so. The swing may be clockwise or counter-clockwise. The relative position of the junction of laminae remains near the center of its body or slightly in the direction of the swing. This of course varies with the amount of swing. In either event the junction in a swing remains closer to the median line, but seen right or left of the center of its body as the case may be. For example: Say the listing is a spinous pivot, body left. This means the body swung counter-clockwise and laterally low on that side. Rarely is the vertebra seen high on the swing side. In the event it is high, it is the result of anomaly or extreme curvature. The junction of laminae would be to

some degree right of its body, in the median line or slightly left of the median line. Repeating, these measurements and positions vary with the amount of body swing.

To differentiate between body swing and body pivot with vertebral laterality in the same direction, the junction of laminae in a spinous pivot, say body swing ¼ of an inch left, will be slightly left of the median line—but to some degree right of its own body as seen from a posterior aspect. Of course the spinous process will be right of its body, also right of the median line. The transversarium foramen on the right will move anterior and up to or possibly beyond an imaginary horizontal line through the base of the odontoid while the left foramen will have moved posterior and laterally lower in relation to the right foramen to the same imaginary line.

The amount of lateral movement in a body pivot, entire vertebra right or left may be greater than the laterality in a body swing or spinous pivot. However, two factors, when clearly understood make this differentiation simple. Repeating: In a spinous pivot the body swings laterally low in an arc but does not twist, so to speak. Second, in a body pivot with entire vertebral laterality, the vertebra twists or rotates—then moves laterally and usually to some degree high on that side. Otherwise it would be seen level.

The right axis, body pivot, entire vertebra say ¼ of an inch left—rotates left, the junction of laminae will be right of its body in accordance to the degree of rotation—and its relation to the median line depends upon the amount of both rotation and vertebral laterality.

For example: Say the rotation is about 2 degrees left. This places the junction of laminae approximately 1/16 of an inch right of the median line and slightly right of the center of its body. Then as the vertebra moved left ¼ of an inch, the junction is carried left of the median line about 3/16 of an inch or not quite as far as the body moved left.

If the rotation is say 5 degrees left, it would place the

junction slightly less than 1/8 of an inch right of the median line. Then as the body moves 1/4 of an inch left, the junction will be about 1/8 of an inch left of the median line and seen about 1/4 of an inch right of its body.

If the body rotated say 20 degrees and then moved left 1/4 of an inch, the junction would probably be slightly right of the median line and would appear much more to the right of its body as viewed from a posterior aspect. Important points in this comparison are as follows:

No. 1. The laterally low posterior swing of the body (spinous pivot) as compared with the level or laterally high tilt of the rotated body (body pivot).

No. 2. The relation of both intervertebral foramina to the median line and the imaginary horizontal line laterally through the base of the odontoid, in a low swing, as compared with the same points of the rotated body (body pivot).

No. 3. The junction of laminae in relation to its body, in a body swing (spinous pivot) as compared with the same points in body rotation (body pivot with laterality).

No. 4. The junction of laminae in relation to the median line in body swing (spinous pivot) as compared with the same points of the rotated body (body pivot with laterality).

To possibly obtain a more thorough mechanical understanding of pivot listings, suggest the drawing of three circles, one within the other. Say the large one 2½ inches in diameter, the small one about 1⅛ inches and then one in between.

Divide them in four quadrants, the upper right No. 1, lower right No. 2, etc. Now mark the outside ring in degrees say 1 to 20, beginning at the perpendicular line on the low part of the small circle and numbering both right and left.

Place the center of the body of axis at the centrum and the junction of laminae on the perpendicular line. Now rotate the body moving the spinous right or left; also

rotate the body and move the entire vertebra right or left and note the position of the various parts of the vertebra with the quadrants, the perpendicular and horizontal lines. Proceed in the same manner by swinging the body right or left at the junction of laminae.

All listings of axis pivots not only reveal the type of misalignment but actually indicate the point of contact, as well. All types demand a different contact.

There is another type of axis misalignment quite frequently seen, that is laterality without rotation. In other words, the entire segment moves right or left without any noticeable twist. This requires still a different point of contact. Refer to Fig. Nos. 87 and 88. The most prominent of all axis misalignments is the body pivot with some degree of body laterality.

Another simple example of axis misalignment refers to the schematic drawings (AP view). See Fig. No. 91-"A"-"B"-"C". A complete study of these types of misalignment should make them more readily understood.

At this point the writer should like to comment on the rotary, under-finger and T.M. moves. These could be, and many times are, a dangerous type of adjustment. First, the chiropractor must know exactly how to proceed with such a move. Secondly, he must know whether the vertebra to be adjusted is the type of misalignment that these sort of moves may be used upon. Whether the tip of the finger, thumb or under part of the forefinger is used to make contact against the spinous process there is more or less force applied against the body of the vertebra. In that event the force applied might move the body out of the median line. It is the opinion that if these moves are to be used, they should be applied to the vertebra wherein the body is out of the median line on the side in which contact is made.

The most dangerous of all so-called unorthodox cervical moves, is the break. The leverage in this type of adjusting is so terrific one could never know what actually might

happen. There is absolutely no control of the vertebra whatever. Though the writer does not recall that this move ever broke or dislocated a neck, he has heard the court give a severe reprimand for using such a precarious and unscientific application.

Repeating: There are two steps in reading the axis, from this aspect. First, is to locate the junction of laminae. Measure from this point to the pedicle, transversarium foramen or to the outer margin of the body. Compare this distance with the opposite side. Should it measure the same the axis is not rotated. If the distance is greater on one side than the other the axis has rotated in that direction and the spinous will be found on the opposite side. The spinous is always located opposite to the rotation of its body. When the junction of laminae is not visible, then measure from an extreme superior point on the light line that extends from the tip of the spinous process to the junction. If the junction of laminae and this light line (ridge of the spinous process) is not visible, then note the intervertebral and transversarium foramen. When the spinous of axis is left, body rotated right, the transversarium foramen will appear larger than the left, and the intervertebral foramen will appear smaller than the opposite one. Vice-versa if the spinous was right.

Second, compare the body or the center of the odontoid, at its base, with the median line. This determines the pivots and body laterality, and further it reveals the part the odontoid plays in the variations found in the interodontoid spaces.

The Atlas

First list the rotation, the laterality, and then the pivot. Because there are no direct points that determine atlas laterality, the rotation should be considered first. In other words, points that may indicate atlas laterality are the result of anomaly, malposition or they are points that also indicate atlas rotation.

When reading atlas rotation without the aid of the base posterior or vertex views, it is necessary to compare de-

scriptive parts and all possible points for both the anterior and posterior rotations, and then make deductions. In other words, add up so many points for anterior rotation and so many for posterior rotation and then subtract.

The following are points in favor of both anterior and posterior rotation, excluding anomalies and malpositions.

Left Transverse Anterior

1. Post. tubercle left of the median line unless atlas is extremely right and rotation slight.
2. Inferior tip of lateral mass below posterior arch smaller.
3. Medial surface of lateral mass larger.
4. Lateral mass appears larger and darker.
5. Inferior surface of lateral mass partially visible.
6. Groove for 1st pair spinal nerves should appear larger.
7. Transverse process wider and shorter.
8. Transversarium foramen partially over-shadowed by the lateral mass.
9. Lateral surface of lateral mass not visible.
10. Space between condyle and lateral mass usually narrower.
11. Length of articulation

Left Transverse Posterior

1. Post. tubercle right of the median line unless atlas is extremely left and rotation slight.
2. Inferior tip of lateral mass below posterior arch larger.
3. Medial surface of lateral mass smaller.
4. Lateral mass appears smaller and lighter.
5. Inferior surface of lateral mass not visible.
6. Groove for 1st pair spinal nerves should appear smaller.
7. Transverse process narrower and longer.
8. Transversarium foramen entirely visible.
9. Lateral surface of lateral mass partially visible.
10. Space between condyle and lateral mass usually deeper.
11. Length of articulation between condyle and lat-

between condyle and lateral mass appears longer.
12. Lateral mass overlaps condyle unless atlas is right.
13. More of the left lateral mass is seen in the foramen magnum unless atlas is extremely left.
14. Left interodontoid space is narrower unless atlas is extremely left or body of axis is right.

eral mass appears shorter.
12. Axis overlaps lateral mass unless atlas is left.
13. Less of left lateral mass is seen in the foramen magnum unless atlas is extremely right.
14. Left interodontoid space is wider unless atlas is extremely right or body of axis is left.

The above is called the point system, and because of the variables all points should be considered before reaching conclusion.

Atlas laterality—As stated previously, there is not any one point that proves atlas laterality or rotation when reading only the lateral and the A to P regular flat cervical spinographs. It requires the base posterior or vertex, together with the A to P regular to actually prove atlas laterality and rotation.

The first indication of atlas laterality, however, is the high side of the angle of atlas reading the A to P regular view; second, is its point of wedge. However, either can be entirely wrong. Atlas high on one side could be the result of malformed condyles or lateral masses; or the point of wedge could be the result of malformed condyles, lateral masses or an irregular occiput, high on one side, low on the other. Understand there are left atlases in right point wedges and vice-versa. The ratio is about fifty per cent.

Checking the point of wedge or laterality of atlas, from the posterior aspect, there are 6 important factors to consider:

1. Angle of atlas high on that side.

2. Rotation of the head in placement.

3. Amount of lateral masses appearing in the foramen magnum.

4. Interodontoid spaces.

5. Spaces between lateral masses and jaw or the proximity of the atlas in relation to the side of the skull, considering, of course, any anomaly of the foramen magnum, which is often found off lateral center.

6. Length of the articulation between condyle and lateral mass, taking into consideration the rotation of atlas.

Repeating—always consider head rotation in placement because it changes spaces and distance according to the degree of malposition.

When approximating the lateral masses in relation to the foramen magnum first consider the rotation of atlas—because when the atlas rotates anterior the lateral mass on that side swings farther into the foramen magnum and the posterior mass tends to move out. So an atlas could be actually right yet the right lateral mass might appear in the foramen magnum more than the left.

The width of the interodontoid spaces varies with atlas laterality, atlas rotation and axis body laterality. Again the atlas might be right, right transverse say slightly posterior and yet the right interodontoid space much narrower than the left due to the body of axis being right.

Spaces between the lateral masses change because of atlas laterality, extreme atlas rotation—then too, the foramen magnum may be off center to the left and even though the atlas might be right it may be actually closer to the left side of the skull. The length of the articulation between condyle and lateral mass varies because of atlas rotation and laterality—also because of the anomaly of condyle which is very frequently present.

Again may I repeat, there is no fixed point that directly proves atlas laterality on the A to P spinograph. All points must be carefully considered and deduced first.

Base posterior (BP or vertex)—This view together with

the lateral and A to P regular makes the ideal set to determine the correct upper cervical analysis. It not only proves atlas rotation without having to use the point system, it is also a part of the atlas axis comparison which proves atlas laterality on condyles.

The laterally high side of the atlas is the first indication of anterior rotation; but not until one actually knows the plane line of atlas is less than 90 degrees from the perpendicular can the atlas be considered anterior on that side. For example: Say the atlas appeared slightly high on the left side, low on the right. Actual measurement (using protractor) reveals atlas more than 90 degrees from the perpendicular. This proves atlas to be posterior in rotation.

The reason for atlas appearing high on the left is because the degree of lateral high tilt of the head on the left is greater than the degree of posterior rotation. In other words, when the atlas is 90 degrees from the median line it is at right angles or without rotation. If atlas plane line is actually 87 degrees from the perpendicular on the left it would be anterior in rotation. Should the head be level or without lateral tilt, assuming no anomalies, the atlas would appear high on the left side.

Now, if the head was tilted low on the left, say 8 degrees the atlas would still be approximately 3 degrees anterior in rotation on the left but low on the left because the lateral head tilt is greater than the degree of anterior rotation. So the accurate way to determine atlas rotation is via BP or Vertex, using a protractor and not depending on just visualizing the atlas laterally high on the film.

Since the advent of the vertex and base posterior, the diagonal is not used to determine rotation but instead pathology, fractures, dislocations, etc. Study and familiarize yourself with the upper cervical spinographs and listings and always make full spine instrument readings before and after adjustment. Decide whether you will be able to make the desired contacts and whether the case can be

or should be adjusted. Don't be too impatient if results are not forthcoming—for there may be a great amount of damage already done and time is a factor. However, if results are not apparent within a reasonable time and there are other readings below which have not responded to the adjustment, then spinograph other regions of the spinal column, if not already taken, and adjust. Be sure to continue making complete instrument readings, and it is perhaps most important not to continue the lower adjusting until further consideration is given atlas and axis.

Fig. No. 92 "D" and "E" reveal pivoted atlas and axis. The pivoted atlas is quite common to some degree but not to a point where contact is changed from one side to the other. The pivoted axis is a common occurrence.

Lateral cervical and upper dorsal—The first dorsal is recognized by the first pair of ribs, its facets, transverse processes pointing diagonally upward while that of the 7th cervical points diagonally downward. Though its spinous is often seen malformed and occasionally larger, the 7th cervical is considered vertebra prominens.

Locate the tip of the spinous process and follow the light line that extends from that point upward to the junction of laminae or get as near to the junction as possible. Measure from this point to the pedicles or lateral margin of the body. If the junction or spinous is to one side of the center of the body, the body is rotated in the opposite direction. Continue in this manner up the cervicals and down the dorsals. Now compare the junction of the first dorsal or this point in close proximity with the same point of the 7th cervical, and 2nd dorsal. If this point of the 1st dorsal is right of the one above and the one below, and if the 7th cervical, 1st and 2nd dorsals are all rotated left, then the 1st dorsal has rotated to a greater degree and its spinous is listed laterally right. Then add to the laterality the lateral tipping of the body—like RS or RI. "S" means superior or the body is high on the right side. Inferior means low on the right side. Repeating, spinal

listings below axis, first refer to the spinous process, then to the rotation of the body of the vertebra. A spinous process cannot be listed right unless the vertebra has first rotated left and its junction of laminae is right of the junction above and the same point below.

The lower dorsal and lumbar sections are read in the same manner, except on the lower dorsal film the starting place is the 12th dorsal, which is compared with the 11th dorsal and 1st lumbar. Reading the lumbar film begin with the 5th lumbar, compare it with the 4th and the 2nd tubercle of the sacrum. The reason for using the 2nd tubercle is because the 1st is usually malformed, cleft or otherwise.

The lumbar pelvis, 14x17 film—This reading is slightly more complicated. The rotated sacrum, rocked, and rotated and superior ilium, laterally bent coccyx and leg deficiency are determined from this view. The superior ilium is a rare condition.

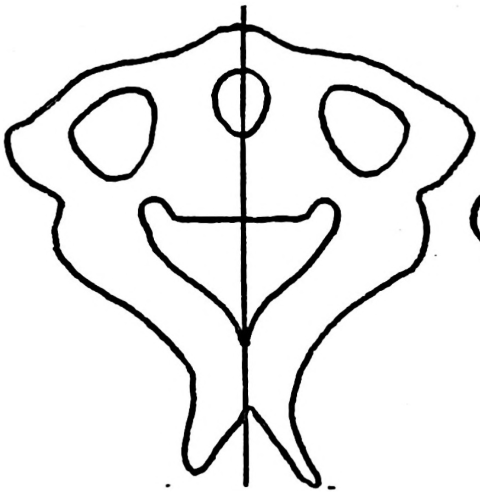
To determine the rotated sacrum, locate the 2nd tubercle —measure from this point to the sacro iliac lines or to where the sacrum and ilium meet at its base. Compare this measurement with the opposite side. The greater distance indicates the base of the sacrum is rotated posterior. The 2nd tubercle is always the key point of sacrum for measuring.

Refer to Chapter 28 to determine the inferior posterior superior spine. This is always called a rocked ilium. When the posterior superior spine is inferior there is usually some rotation of the ilium. When the rotation is internal, the ala or wing becomes narrower, the body appears wider, the ischium usually not visible and the obturator foramen larger. This tends to pull the sacro iliac articulation apart at the posterior.

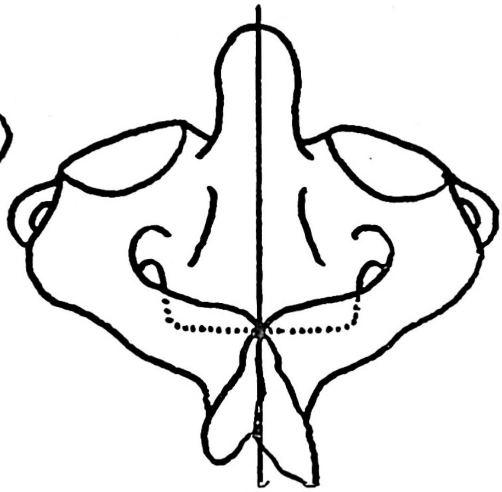
If the rotation is external the ala is wider, the body narrower, the ischium visible (at least partially) and the obturator foramen smaller. This opens up the sacro iliac articulation at the anterior.

The superior ilium is determined according to the line drawing. See Chapter 28 for complete detail.

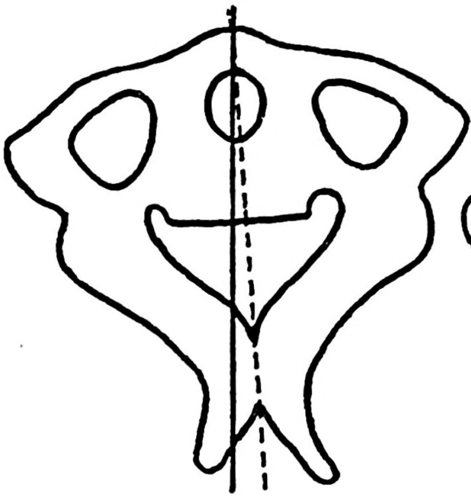
Leg deficiency, when not due to surgery, etc., but actual misalignment, is determined by the wedge lines. The point of the wedge indicates the high femur—the blunt of the wedge is the side of leg deficiency or long leg. Other indications are the lateraly tipped sacrum on that side, ilium and the pubic arch lower on that side providing the posterior superior spine is not actually inferior. In the event there is inferiority of the posterior superior spine when the leg is deficient, that half of the pubic arch may appear higher than the opposite side. The laterally or anteriorly bent coccyx is determined simply by observation.



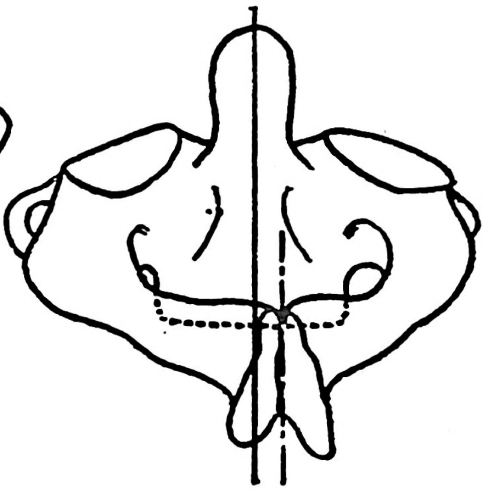
(Sup. View)
Normal Axis
Figure No. 79



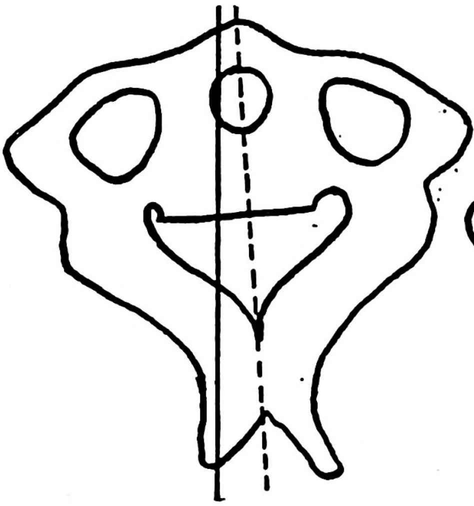
(A-P View)
Normal Axis
Figure No. 80



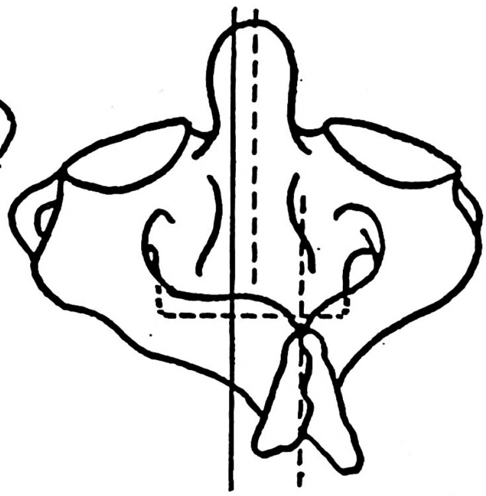
(Sup. View)
Axis Rt.—Body Pivot
Figure No. 81



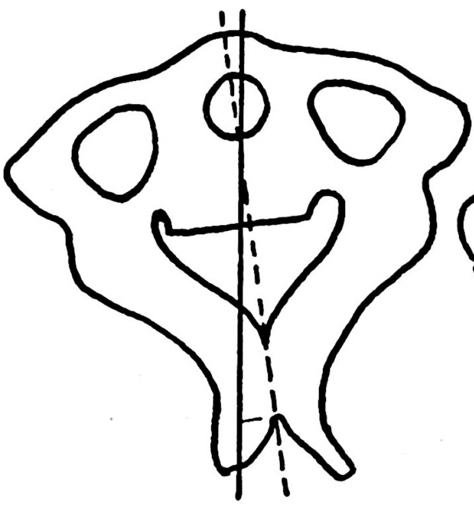
(A-P View)
Axis Rt.—Body Pivot
Figure No. 82



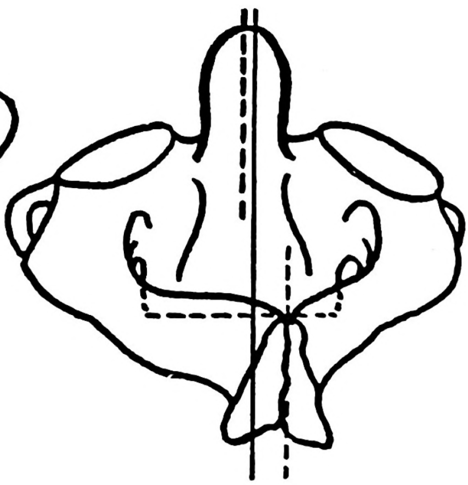
(Sup. View)
Axis Rt.-Body Pivot-Entire Vert. Rt.
Figure No. 83



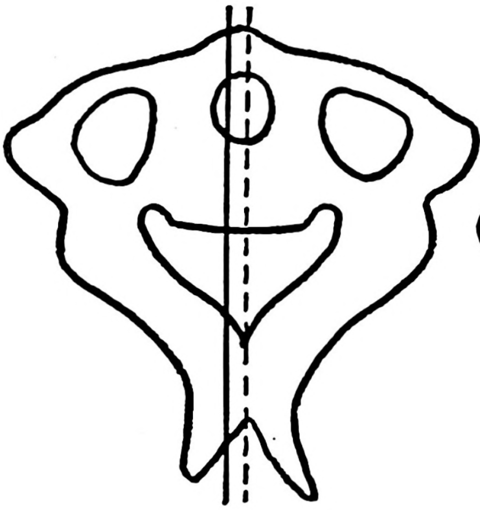
(A-P View)
Axis Rt.-Body Pivot-Entire Vert. Rt.
Figure No. 84



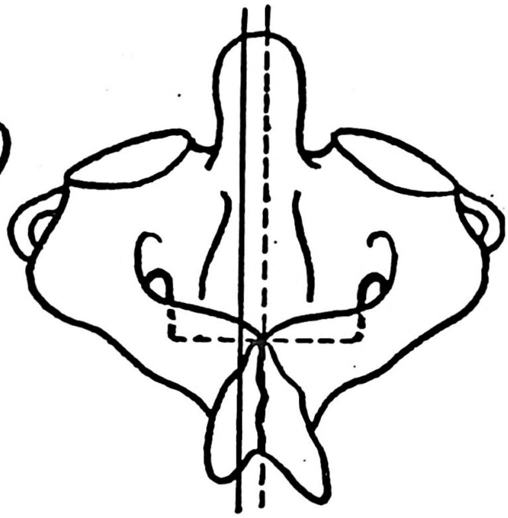
(Sup. View)
Axis Rt.-Body Pivot-Entire Vert. Lt.
Figure No. 85



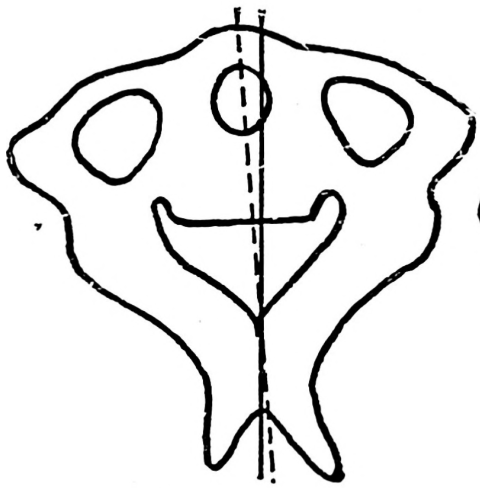
(A-P View)
Axis Rt.-Body Pivot-Entire Vert. Lt.
Figure No. 86



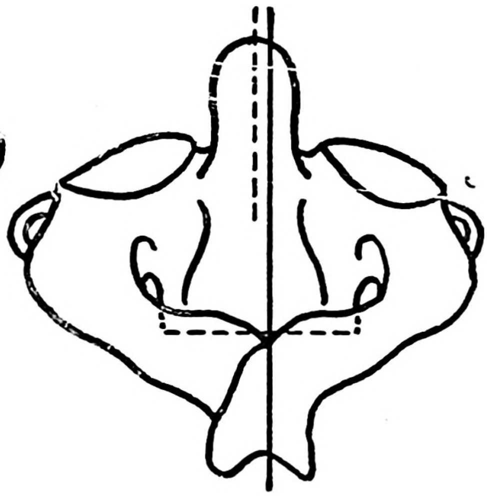
(Sup. View)
Axis-No Rot.-Entire Vert. Rt.
Figure No. 87



(A-P View)
Axis-No Rot.-Entire Vert. Rt.
Figure No. 88



(Sup. View)
Axis-Spinous Pivot, Body Lt.
Figure No. 89



(A-P View)
Axis-Spinous Pivot, Body Lt.
Figure No. 90

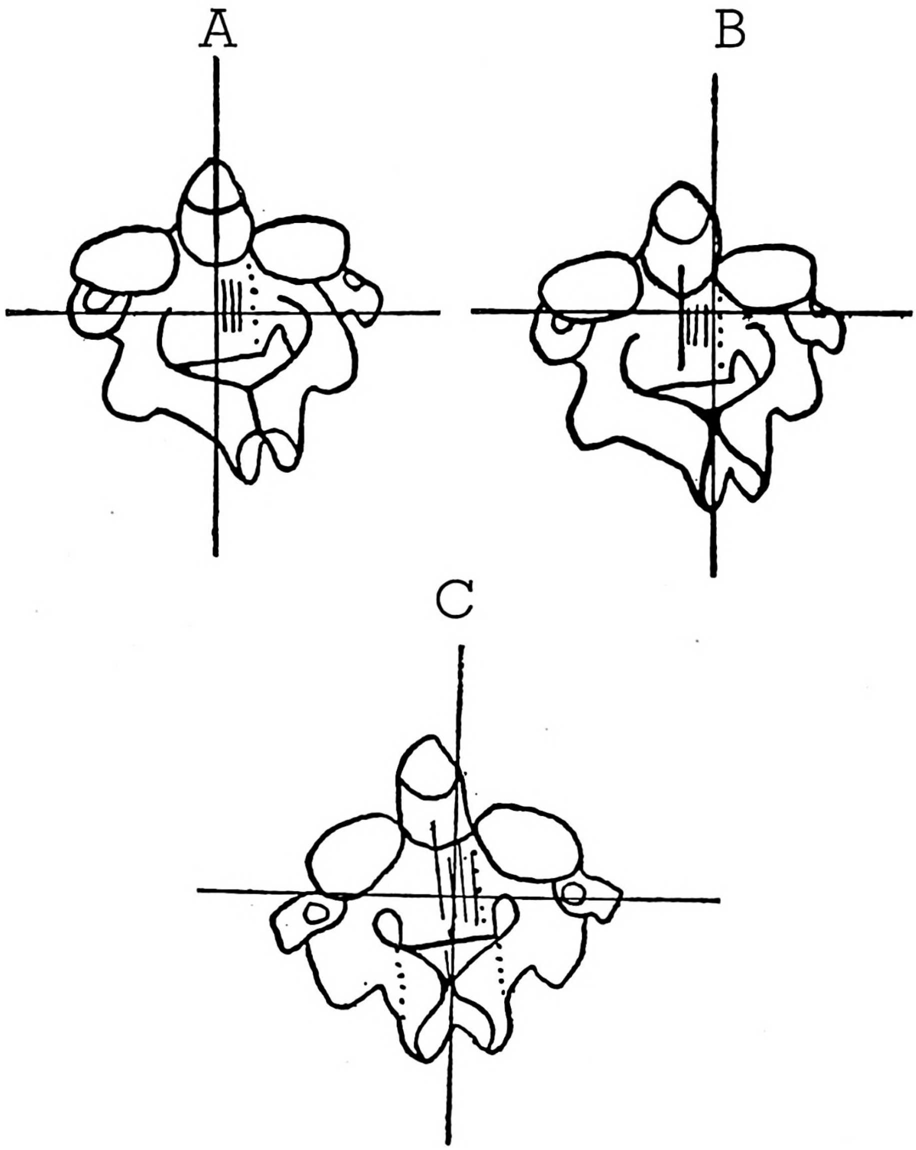


Figure No. 91
(AP View)
"A"—Axis right—body pivot
"B"—Axis right—body pivot—entire vertebra left
"C"—Spinous pivot—body left

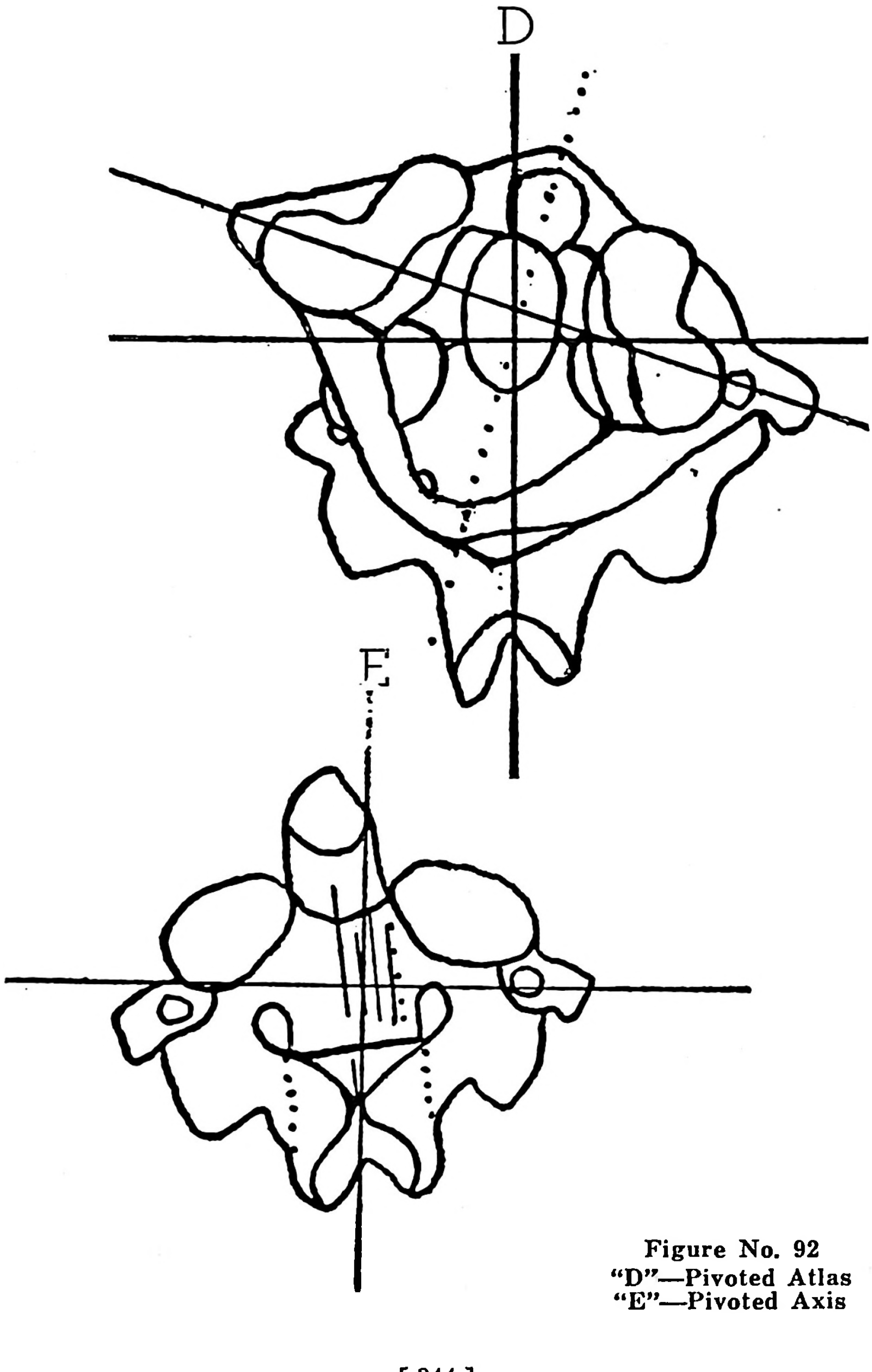


Figure No. 92
"D"—Pivoted Atlas
"E"—Pivoted Axis

CHAPTER 30

Cervical Analysis

(Reading With Lines)

Cervical Views—Throughout this chapter the regular three cervical spinographs (Lateral, AP regular and Base Posterior of the same case) are analyzed and the listings in each instance are explained.

Fig. No. 93 represents the lateral cervical spinograph. (See Fig. No. 62 for placement.) Male, age 22, weight 160 lbs. Placement good, although there is a slight rotation of the head in placement. This is indicated by the visibility of the posterior lines of the jaw. Only one is visible with proper placement. Also the chin is slightly low but not enough to change the listing. Exposure technique is excellent. There is no pathology except for a possible slight fusing between the zygapophysis of 7th cervical and 1st dorsal. There is no anterior bending of the cervical spine except from the 5th cervical down. This would be considered a military neck, an abnormal condition.

The axis tends to follow the atlas anterior. This is evidenced by the body tipping slightly forward; and the light posterior line of the body has broken the continuity of the cervical arc, made up of similar lines below. There is practically no space visible between the fovea dentalis articulations.

Atlas is anterior inferior. There is always some degree of anteriority in the misalignment of atlas because when

it moves out of its habitual position it first twists. Further, the light curved line of the posterior tubercle, representing the posterior internal margin of this first neural ring, is anterior to the same sort of line of the spinous of axis. Though there is nothing definite concerning this point there are variations in the external dimensions of the posterior arch, it is a point to consider. Inferiority is proved by the diagonal line through atlas having an angle of less than 8 degrees upward at the anterior. Inferiority appears greater than the degree of anteriority—therefore, the plus sign over the "I." The anterior tipping of the axis is never listed, since it could not go forward under normal conditions unless the atlas first moved anterior. The adjustment would be the atlas to correct the anteriority, rather than the axis. The listing is A I (inf. plus).

Diagonal—Lines are not drawn on this view. Since the advent of the base posterior and vertex, the diagonal is not used to determine rotation. It is valuable, however, in fractures, dislocations, pathology, ankylosis, etc. So it is seldom taken, except under these circumstances.

Anterior Posterior Regular View—This is the most important of all spinographic views; yet, it takes other views to determine a complete upper cervical listing. In fact, it is the most difficult to take. Fig. No. 94 portrays the anterior posterior regular or natural view (see Fig. No. 63 for placement). Note that placement is good, although there is minute head rotation left, with slight lateral head tilt. The exposure was slightly heavy. Had the time factor been one-fourth of a second less, outlines would have been sharper. However, it is very readable. (Note also that lines are properly drawn.) The basic line (top line) is plumb, or level with the skull; it is slightly high on the left because the skull tips slightly low on the right. The median line is at right angles to the basic line, extends down through point of bisection, dividing the foramen magnum. It should always divide the foramen magnum but not the skull when the foramen magnum is off-center. The spinous

of axis is left of its own body. If this slight amount of head rotation were eliminated, however, the spinous would appear minutely more to the left. The body is slightly left of the median line. The rotation of axis is greater than the laterality of the body in relation to the median line. Therefore the axis is left, body pivot, entire vertebra slightly left. The anomaly seems to be the right condyle. It is slightly lower than the left and has slightly less pitch, or angle.

Rotation of atlas is next read by comparing the descriptive parts with one another. That part of the right lateral mass below the posterior arch is larger, the medial surface slightly smaller and perhaps there is less of its inferior surface visible. These are points true to a posterior right transverse, anterior left. The overlapping of the left lateral mass and condyle indicates anterior rotation on the left, or left laterality. The left lateral mass being in the foramen magnum more than the right indicates anterior rotation on the left or right laterality.

The space between the left condyle and the left lateral mass, being slightly narrower than the opposite side, and the left transverse appearing slightly narrow, indicates the left transverse anterior in rotation. The left transverse process appears shorter than the right. The left interodontoid space is slightly narrower than the right. This seems to be mainly the result of body laterality of axis. All points seem to favor the atlas having rotated right (left transverse anterior; right posterior).

Atlas Laterality—Point of wedge is to the left with the atlas high on the left. So it is assumed the laterality is left because when the atlas moves laterally it usually raises up on the condyle and the tendency is to rotate anterior. Should it rotate posterior, it is likely to be the result of a malformed condyle. Further, as it moves up on the condyle it brings the wedge lines closer together—therefore the point wedge. There are two other points indicating a left atlas. The atlas is minutely closer to the

left side of the jaw. The jaw extends very slightly left, which indicates the head is rotated slightly left in placement. If this malposition were eliminated the atlas would appear slightly closer to the left side of the skull. That would be a point in favor of a left atlas, because the foramen magnum is in the center of the skull, or nearly so. The left lateral mass appears in the foramen magnum slightly more than the right. Assuming the left transverse anterior, would indicate a left atlas. It appears that both rotation and laterality of atlas are very slight.

The axis usually follows the atlas laterally, so this could be another point in favor of left laterality of atlas. Note that the atlas and axis seem to have rotated in the same directions. The atlas appears slightly high on the left side, which would be in accordance with a left atlas. The left condyle is minutely higher than the right, but the head tilt is slightly higher on the left. My opinion is the atlas might be level if head tilt were eliminated. The indication now favors a minutely left atlas. If this set only consisted of the lateral and A to P regular, the listing would be atlas A I (I plus), apparently very slightly left; left transverse anterior. One thing is sure, however—this is a typical borderline case and a Base Posterior view is now most important.

Base posterior or vertex—Both placement and exposure technique are very good. Incidentally both views are marked and read the same insofar as the directions in the misalignment are concerned. However, they are placed differently. Fig. No. 95 portrays the base posterior. See Fig. No. 64 for placement.

Note that the line through the center of each transversarium foramen points upward on the left. This is only the first indication of the anterior rotation on the left side (see Fig. No. 95). Comparing the horizontal with the perpendicular, the left side of atlas is less than 90 degrees from the median line. This proves atlas rotation, anterior on the left. Note that there was no reason for using the point system here.

Atlas axis comparison—Repeating this is a simple and quick way to determine atlas laterality. The degree of accuracy is very high. Measuring from the center of the base of the odontoid to the center of the right transversarium foramen, then transferring this measurement to the left side with a short scribe, indicates the atlas is very slightly left of the axis. Now, comparing the distance between the scribe and the center of left transversarium foramen with the distance between the center of the base of the odontoid and the median line on the A to P regular film, we find both left and the latter distance greater. This means the atlas is slightly left on the condyles.

The lateral listing can now be checked; first by comparing the center of the anterior arch with the center of the basilar process or the perpendicular line (Base Posterior view). Note the anterior arch conforms to the perpendicular with the rotation anterior on the left. Think of the rotation being eliminated or atlas level, the anterior arch would then be slightly left of the center of the basilar process. We call this compensating in the analysis.

Continuing with this idea of compensation, note the lateral masses (AP view) appear entirely divided in the foramen magnum or nearly so. Bear in mind the left transverse moving anterior in rotation causes the lateral mass to swing into the foramen magnum while the right tends to move out. So with the amount of lateral masses evenly divided within the foramen magnum, compensate for the anterior rotation and the right mass would appear in the foramen more than the left, indicating a left atlas.

Another point indicating a left atlas refers to the interodontoid spaces; the body of axis is slightly left of the median line. This would tend to decrease the left interodontoid space, naturally widening the right. Compensating for the axis vertebra left would tend to decrease the right interodontoid space, and widen the left. In other words, if the laterality of the axis could be eliminated the left interodontoid space would actually appear wider. In

that event and with the left transverse actually anterior in rotation, the atlas must be left on the condyles even though a slight malposition exists.

You will find this idea very simple if only you will realize that the body of axis is compared with the median line on the A to P regular film; and the atlas is compared with the axis on the base posterior film. Then it is only a matter of simple addition or subtraction.

Nasium—This view is not exhibited here because we seldom include the nasium with the cervical set. However, the median line is drawn the same as the A to P regular spinograph. The horizontal is drawn from where the lower line of the posterior arch meets the posterior root of the transverse on this film, to the same point on the opposite side. This determines the lateral tipping (see Fig. No. 65a).

The wedge lines point to the left, and the horizontal line on the base posterior is slightly high on the left, which agrees with the final listing. See Fig. Nos. 94 and 95.

Atlas—A I (inf. plus) very slightly left; left transverse minutely anterior.

Axis—Left; body pivot; entire vertebra slightly left.

Atlas—high left side.

Axis—high left side.

The symptoms in this case are vomiting after meals (diagnosed as gall bladder condition); sinus, and pains in chest.

Chirometer reading is low on the left side, which is in accord with the final listing.

Figure No. 93

Lateral Cervical
(with proper line)

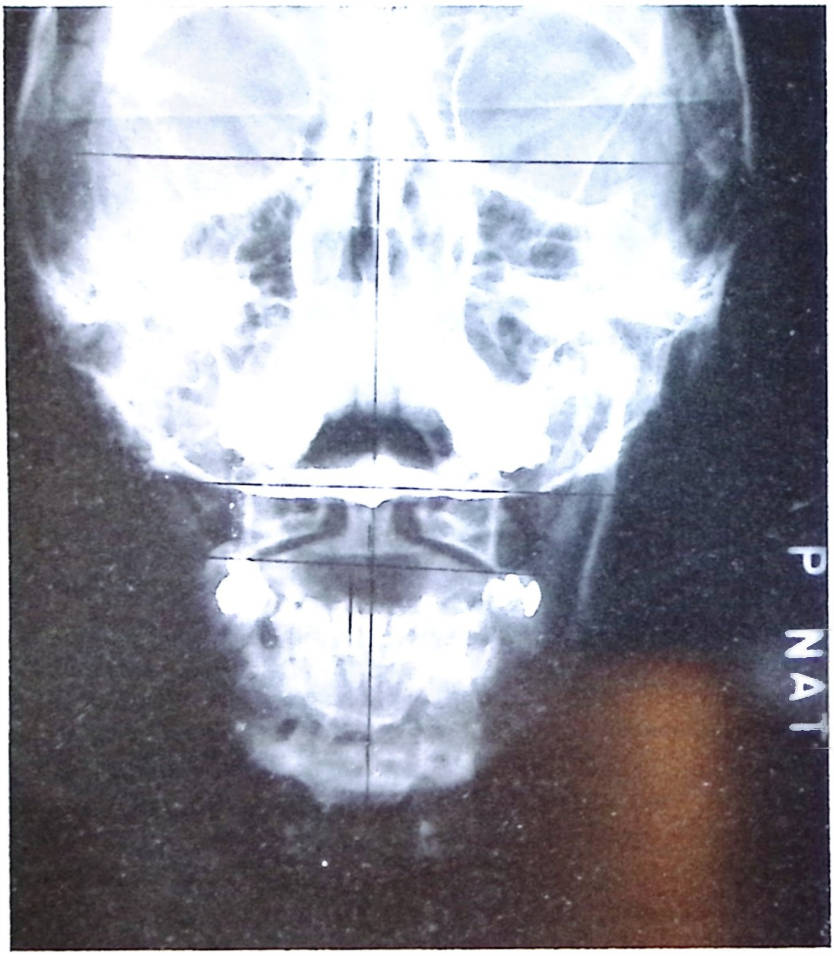


Figure No. 94

AP Regular Cervical
(with proper lines)

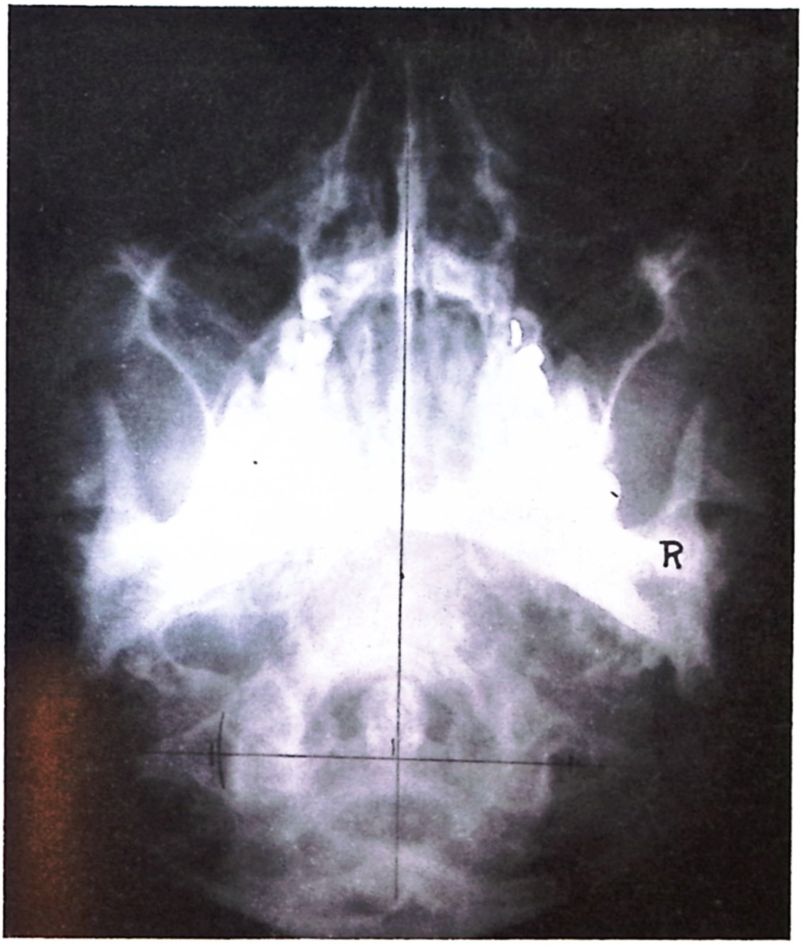


Figure No. 95
Base Posterior—AP View
(with proper lines)

CHAPTER 31

The Normal and Abnormal Spine

The spinal column is flexible, and is located in the posterior medial line of the body. In the child it consists of 33 movable segments; the sacrum includes five and the coccyx four. But in the adult there are 26 segments in the spinal column of which the sacrum is one and the coccyx is one. Ossification of the latter two takes place about the age of puberty. The spine consists of only 24 segments and these are known as true movable segments or true vertebrae, while the sacrum and coccyx of the adult are known as false vertebrae; so actually the spinal column is made up of 24 true vertebrae and two false.

The length of the male spine is approximately 23 inches, while that of the female is shorter. The spinal column is from 27½ inches to 28¾ inches long.

Anatomically there are seven cervicals, twelve dorsals, five lumbars, one sacrum and one coccyx.

The length of the cervical region is approximately five inches, the dorsal, eleven inches, the lumbar region, seven inches, and the sacrum and coccyx, five and three-fourths inches.

In early life the spinal column assumes two primary and two secondary curves; the primary being the dorsal and the lower lumbar and sacral area, while the cervical and lower dorsal and upper lumbar form the secondary curves. Curves are normal and curvatures abnormal.

From an anterior posterior view the spine takes on two general pyramids. The large pyramid has its apex in the upper cervical region and the base at the fifth lumbar, and a second smaller pyramid with its base at the sacrum and the apex at the coccyx. Within the large pyramid there appears to be other pyramids; first, the entire cervical region with its apex at the axis and the base at the first dorsal; second, an inverted pyramid with its base at the first dorsal and its apex at the fifth dorsal, and the third pyramid with its apex at the fifth dorsal and the base at the fifth lumbar. This description gives one an idea of the variation in size of the neural rings, for the spinal cord is largest in the cervical and lumbar regions and smallest in the middle dorsal region.

The spine consists of typical and peculiar vertebrae. The typical are from the third to sixth cervical inclusive, second to eighth dorsal inclusive, and the first four lumbars. The peculiar are the atlas, axis, seventh cervical, first, ninth, tenth, eleventh, twelfth dorsals, and the fifth lumbar.

In the cervical region the transverse, spinous processes, lamina and posterior arch are contacted. Points of contact in the dorsal area are the spinous processes, laminae, as well as the transverse processes. In the lumber region the spinous and mammillary processes, as well as the laminae are contacted. Sacrum contacts are made on the right or left superior portion of the base for rotations, and on the apex for a low anterior sacrum. The ilium may be contacted at its superior crest for superiority, or on the posterior superior spine for inferiority. The coccyx may be contacted externally for posteriority and laterality, and internally for anteriority.

Though the atlas and axis have always been contacted more or less, the writer suggests that you hesitate in giving an atlas adjustment until you have thoroughly familiarized yourself with its descriptive parts and all directions in the misalignment as well. To consider the axis in the same manner may be exceedingly advantageous.

Spinographs have proved that the atlas rotates in its misalignment. To attempt to adjust an axis only because it palpates right or left of the median line may increase or decrease the normal alignment between atlas and axis. The pivots of axis must be first determined, then the laterality of the body to know where to make contact.

One cannot spend too much time in study of the descriptive parts, the normal and the abnormal or the anomalies and malformations of the spinal column. As you continue on through this text, no doubt you will readily realize why this hesitancy has been suggested.

The subject of spinal abnormalities is truly important. Such anomalies are, perhaps, the reason many erroneous chiropractic listings are made, and no doubt it plays an important part in the case of border-line failures in specific adjusting.

Curvatures, exostosis and ankylosis, trauma, as well as the dyssymmetry existing throughout the vertebrae are all included in the study of anomalies and malformations which we find daily in spinal X-ray examinations.

To be a successful analyst one must have mechanical ability, know what causes the gradation of shadows on the film (from both the physiological and photographical standpoints) and understand the spinal column thoroughly and its articulations, as well as being able to recognize them on the film. In other words, he must be able to see the normal through the abnormal.

Three or more adjacent vertebrae constitute a rotation or curvature. Rotation is without lateral bending. Curvatures are anterior, posterior, and lateral. Military neck (cervical spine) is void of either posterior or anterior bending. It may be perpendicular, straight or diagonal.

Left Rotation—All vertebrae are rotated left, spinous processes are seen right of their bodies. See Fig. No. 96.

Right Rotation—All vertebrae are rotated right, spinous processes are seen left of their bodies. See Fig. No. 97.

Lordosis—Abnormal anterior bending. See Fig. No. 98.

Kyphosis—Abnormal posterior bending. See Fig. No. 99.

Left Scoliosis—Left lateral bending with spinous processes following the convexity, which means the vertebrae have all rotated right. See Fig. No. 100.

Right Scoliosis—Right lateral bending with spinous processes following the convexity, which means the vertebrae have all rotated left. See Fig. No. 101.

Left Rotatory Scoliosis—Left lateral bending with spinous processes following the concavity, which means the vertebrae have all rotated left or with the head. See Fig. No. 102.

Right Rotatory Scoliosis—Right lateral bending with spinous processes following the concavity, which means the vertebrae have all rotated right or with the head. See Fig. No. 103.

It is absolutely necessary to know the type of curvature in order to make proper stance, correct contact and line of drive.

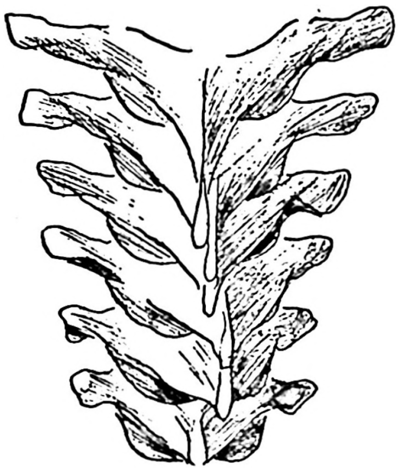


Figure No. 96
Left Rotation

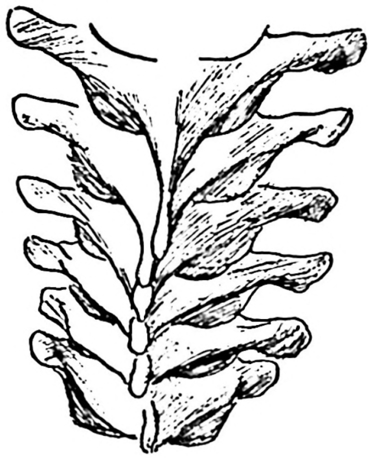


Figure No. 97
Right Rotation

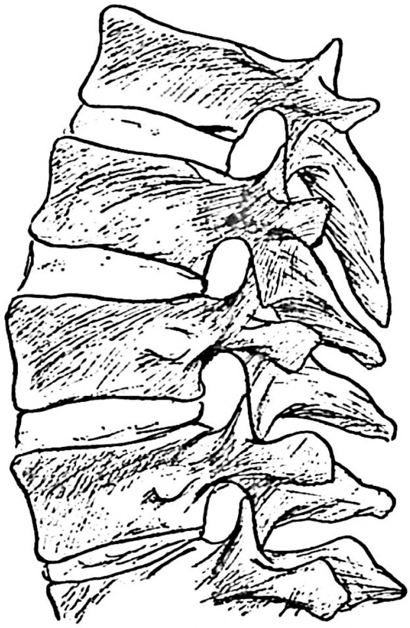


Figure No. 98
Lordosis

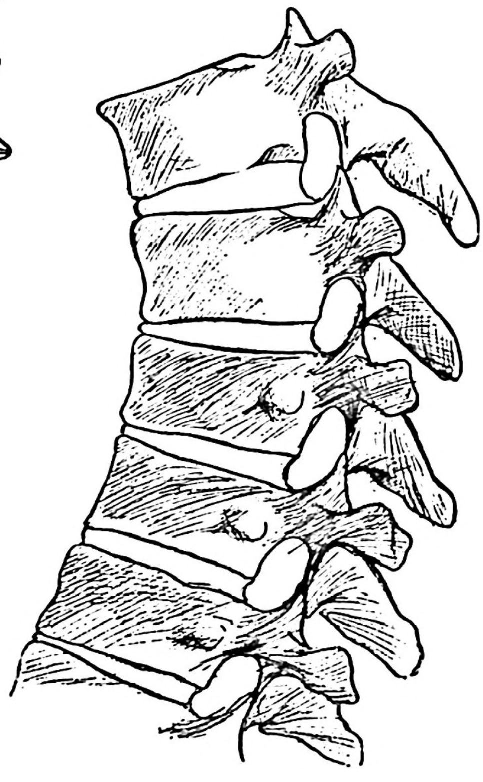


Figure No. 99
Kyphosis

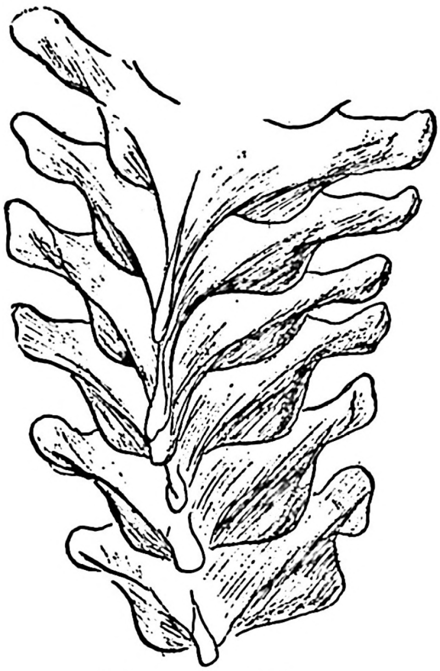


Figure No. 100
Left Scoliosis

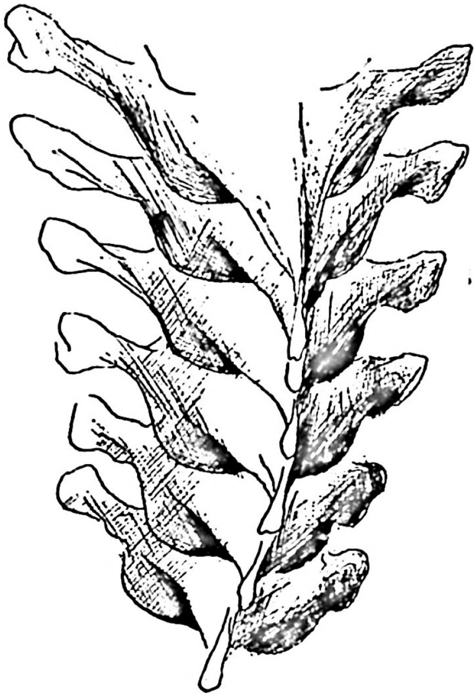


Figure No. 101
Right Scoliosis

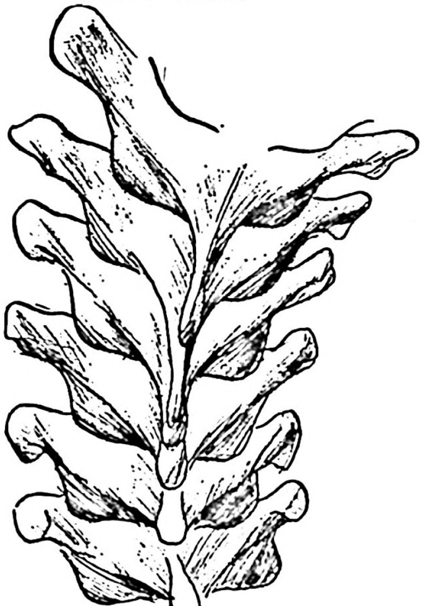


Figure No. 102
Left Rotatory Scoliosis

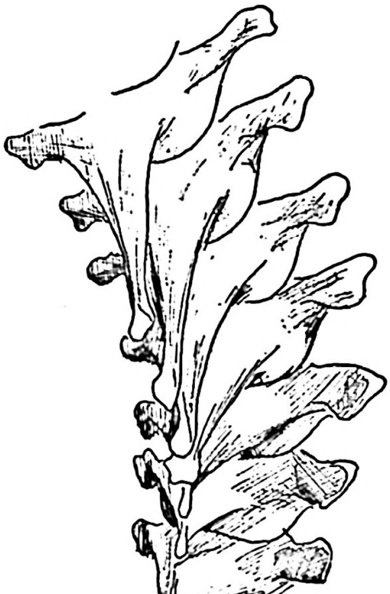


Figure No. 103
Right Rotatory Scoliosis

CHAPTER 32

Sectional and Full Column Spinographs with Analysis

Spinography entered the field of radiography at the Palmer School of Chiropractic in 1910, and has continued to attract the attention of the scientific world. But only within the last few years has it reached its present high degree of perfection. Until its birth, spinal subluxations—or misalignments, as they are now regarded—were determined only by means of palpation. As a matter of fact, this method has been carried on more or less even to the present time. However, Dr. B. J. Palmer himself, and renowned individuals in the field of orthopedic surgery have admitted they were many times in error—as high as 50 per cent or more. Experiments and investigations, which are constantly carried on, have revealed and have proved by the spinographic films why palpation could be in error. So it is obvious that spinography, properly applied, does more than read misalignments. It reveals the approximate degree of misalignment, pathology, the actual existence and the location of exostosis or ankylosis, anomalies, and malformations, and the abnormal contours—all of which could mislead anyone in palpation.

Scientific research with scientific equipment has proved that the two higher points of manifestation afford more

permanent chiropractic results. However, to adjust other vertebrae in some instances, seems to bring quicker relief —but it's usually wise to reconsider atlas or axis before continuing with lower adjustments.

Chiropractically the spine is divided into zones, the boundaries being governed by the distribution of the spinal nerves. So it is necessary that the spinographic technician, working generally, expose and analyze the films according to zones for certain physical conditions.

It is understood, however, that listings below 4th cervical are not correctly made from the regular AP atlas axis view because of the manual rotation of the patient's body made in placement. This is usually required to align such constant points as the external occipital protuberance and the frontal groove or bridge of the nose. For example, let us say the 5th cervical was actually slightly left. Because of the habitual carriage of the patient's head it is necessary to manually rotate the patient's body, say 8 degrees left to align the two constant points. Then in all probability the 5th cervical would appear in line, or even right on the film. If the degree of vertebral rotation was actually extreme, then by rotating the patient's body in this manner the degree of vertebral rotation would be lessened on the film. By the same token atlas or axis should not be read on the full spine films. Repeating: Placement is different. Atlas and axis is actually the first section. However, they will not be depicted here because they are elsewhere in the cervical group analysis.

See Fig. No. 104 which depicts the L.C. and U.D., the second section. Note that either the junction of laminae or a point near the junction on the light line that extends from the tip of the spinous upward—or even the tip of the spinous—has been marked to indicate the correct point from which to begin the measurement.

Placement and exposure technique are good. Both the spinous of axis and the junction of laminae of the 6th dorsal are visible. So the 3rd cervical can be compared with the axis, and the 5th dorsal compared with the 6th dorsal.

This is why it is necessary to overlap at both ends of the film. The spinous of 1st dorsal being closer to the right side of its body means the body has rotated left. Both the 7th cervical and 2nd dorsal have rotated in the same manner, except the 1st dorsal is rotated the most. This means the 1st dorsal is actually right of the one above and the one below. The body tips slightly high on the right side. So the 1st dorsal is listed "RS"—right and slightly superior. The 7th cervical up through the 4th cervical all are rotated left but not listed individually because they are in line with one another.

The 2nd and 3rd dorsals are also rotated left and high on the right side, the same as the 1st, except the 2nd is rotated slightly more than the 3rd. Therefore, the 2nd is listed "RS" too. However the 1st dorsal is checked as being the greater misalignment of the two.

The 4th dorsal is listed "RS" because its spinous is right of its own body and right of the one above and the one below. The 5th dorsal appears rotated. However, the 5th would palpate left because its spinous is bent left. The listing of the L.C. and U.D. section is:

1st dorsal RS.
2nd dorsal RS.
4th dorsal RS very slightly.
5th dorsal....Bent L.
6th dorsal RS very slightly.

There is a very slight right scoliosis from the 5th cervical through the 4th dorsal. The 1st dorsal is the apex.

When thinking in terms of zones, these misalignments indicate interference to—or a condition of—the bronchi, shoulders, arms, hand, heart and the liver.

Lower dorsal (3rd section)—Film placement is low because only the lower portion of the spinous of 6th dorsal is visible. (See Fig. No. 105.) However, it so happens that the entire 6th cervical is visible on the L.C. and U.D. film. So a comparison of the 5th and 6th dorsals can be made on the L.C. and U.D. film.

The short ribs belong to the 12th dorsal. Measuring from the junction of laminae or tips of the spinous processes prove the 12th dorsal and all other dorsals in this section except the 6th have rotated right. Their spinous processes are seen on the left side of their bodies. The 6th dorsal is rotated left slightly and the 1st lumbar is rotated right. Comparing the 12th dorsal with the 11th and the 1st lumbar, its spinous is right but cannot be listed right because it is rotated right. This means that either the 11th dorsal or 1st lumbar or both have rotated more than the 12th. The 12th, 11th and 10th are in line with each other within the slight curvature. Comparing the 10th with the 9th and 11th, the 10th is left and rotated more than the one above or the one below. So the 10th is listed "L." There seems to be no lateral tipping. Comparing the spinous of the 9th with the 8th and 10th, its spinous is right. But here, again, it cannot be listed right because it is rotated right, and adjusting from the right side would increase its rotation. However its spinous is bent right slightly, therefore it would palpate right. The 8th dorsal is left, because it is rotated right and left of the one above and the one below; also, it tips low on the left. So the 8th dorsal is misaligned and listed "LI." Comparing the 7th with the 6th and the 8th, the 7th is right. But here, again, it cannot be listed right because it is rotated right. The listing of the lower dorsal section is:

6th dorsal RS very slightly.

8th dorsal LI.

10th dorsal L.

According to zones, these misalignments would indicate interference to—or a condition of—the pancreas, spleen, stomach, kidneys, eyes, etc.

Lumbar (4th section). Placement and exposure technique are perfect. (See Fig. No. 106.) The spinouses of the 4th and 5th are bent right. The 5th lumbar is rotated right slightly and its spinous is left of the 2nd tubercle of the sacrum. It is also left of the 4th, which is rotated slightly

left. So the 5th lumbar is listed left. The 4th is left of the 3rd and 5th, but cannot be listed as a left misalignment because it is rotated left. The 2nd and 3rd are in line with the 4th and rotated in the same direction. The 1st is rotated right, tipped low on the right side, high on the left and slightly left of the 12th dorsal and 2nd lumbar. So the 1st lumbar is listed "LS." There is a left rotatory scoliosis 2nd lumbar through the 4th lumbar. The 3rd lumbar is the apex. Final listings of this section are:

1st lumbar LS slightly.

4th lumbar....Bent R.

5th lumbar LI slightly—Bent R.

Referring to zones, these two misalignments would indicate interference to—or a condition of—small intestines or the ureters, peritoneum, bladder, uterus, rectum, etc.

Sacrum and Coccyx (5th section). Placement and technique exposure are very good. (See Fig. No. 107.) Mottled and dark shadows in the pelvic area indicate gas and fecal matter.

The 5th lumbar is rotated right. The base of the sacrum might be very slightly posterior. The coccyx appears fused to the sacrum. The left posterior superior spine appears slightly inferior in relation to the sacrum. This means the left ilium has rocked towards the posterior. This has a tendency to raise the pubis on that side.

Leg deficiency and the rotated ilium are not listed from the 8x10 sectional view, but from the lumbar pelvis (14x17 film). However, there is evidence of a rotated ilium because of the difference in the size of the obturator foramen—though this could be an anomaly. There is also indication of left leg deficiency because the sacrum tips slightly low on the left. Such indications should demand a 14x17 lumbar pelvis exposure. This section and the 14x17 pelvis view are taken in cases of sciatica and conditions of the rectum, anus, legs, etc. Misalignments of this part of the spinal column have much to do with muscular tension.

Symptoms concerning this case are frequent colds, condition of the eyes and hemorrhoids.

Final listings of the entire sectional spine are:

1st dorsal RS.
2nd dorsal RS.
4th dorsal RS (very sl).
5th dorsal....Bent L.
6th dorsal RS (very sl).
8th dorsal LI.
10th dorsal L.
1st lumbar LS (sl).
4th lumbar....Bent B.
5th lumbar LI (sl)—Bent R.

No positive listings except 5th lumbar left and coccyx fused to sacrum.

2nd through 4th lumbar left rotatory scoliosis—3rd lumbar apex.

Left posterior superior spine may be very slightly inferior, with a possible left leg deficiency. However, this condition is determined from the larger film when all the innominates and ischium are visible.

SPINAL COLUMN 14x17 ANALYSIS

Cervical Dorsal View—(Fig. No. 108.) This is read like the 8x10 lower cervical upper and lower dorsal views—by first locating and comparing the 1st and 12th dorsals with the one above and the one below, etc. Listing of the cervical dorsal:

6th cervical LI (sl).
1st dorsal L.
5th dorsal....Bent R.
6th dorsal LI.
7th dorsal....Bent L.
8th dorsal L (sl) Bent R.
9th dorsal....Bent L (sl).
12th dorsal LS (sl).

sl. left scoliosis from 4th cerv. to 7th dorsal. (1st dorsal apex.)

Lumbo Pelvic View (Fig. No. 109). This view requires lines to determine leg deficiency and the superior ilium. The lumbars and rotated sacrum are read the same as the lumbar, sacrum and coccyx sectional views. The mottled appearance on both the right and left sides of the pelvic cavity is fecal matter. The 2nd and 5th lumbars are slightly left. Though the 3rd is right of the 2nd and 4th, it could not be listed right because it is rotated right. Repeating: Lateral spinal listings below axis refer to the spinous processes; superiority and inferiority refers to the lateral tipping of the bodies of the vertebrae. Also, there is left leg deficiency which is indicated by the wedge lines. Again repeating: The blunt of the wedge is always on the side of the deficient leg, and the point of the wedge indicates the high femur. There was no history of surgery or fracture of the limbs, so the deficiency, no doubt, is the result of misalignment.

The pubic bone on the right side is higher than the left, which would be true with left leg deficiency. The two short lines on the left are higher in relation to the perpendicular than the lines on the right, with the difference being about the same. This is evidence of leg deficiency with no indication of a superior ilium. There doesn't appear to be any posterior rocking of the ilium, as indicated by the pubis, acetabulum and the heads of the femurs.

Listing of the lumbo pelvis (Fig. No. 109):

2nd lumbar LS (sl).

4th lumbar....Bent L.

5th lumbar L (sl).

Approximately 1/8" left leg deficiency. The apex of the sacrum is slightly low on the left side. The left innominate appears to be rotated internally, slightly.

The symptoms in this case point to tonsillitis and a stomach condition. Patient has constipation and, occasionally, pain down his left leg.

Final listings (Fig. Nos. 108 and 109) of the two 14x17 spinal column views below axis are:

6th cervical LI (sl).

1st dorsal Left

5th dorsal....Bent R.

6th dorsal LI.

7th dorsal....Bent L.

8th dorsal L (sl)—Bent R.

9th dorsal....Bent L (sl).

12th dorsal LS (sl).

Slight left scoliosis from 4th cervical to 7th dorsal (1st dorsal apex).

2nd lumbar LS (sl).

4th lumbar....Bent L.

5th lumbar L (sl).

Approximately 1/8″ left leg deficiency. The apex of the sacrum is slightly low on the left side. The left innominate appears to be rotated internally, slightly.

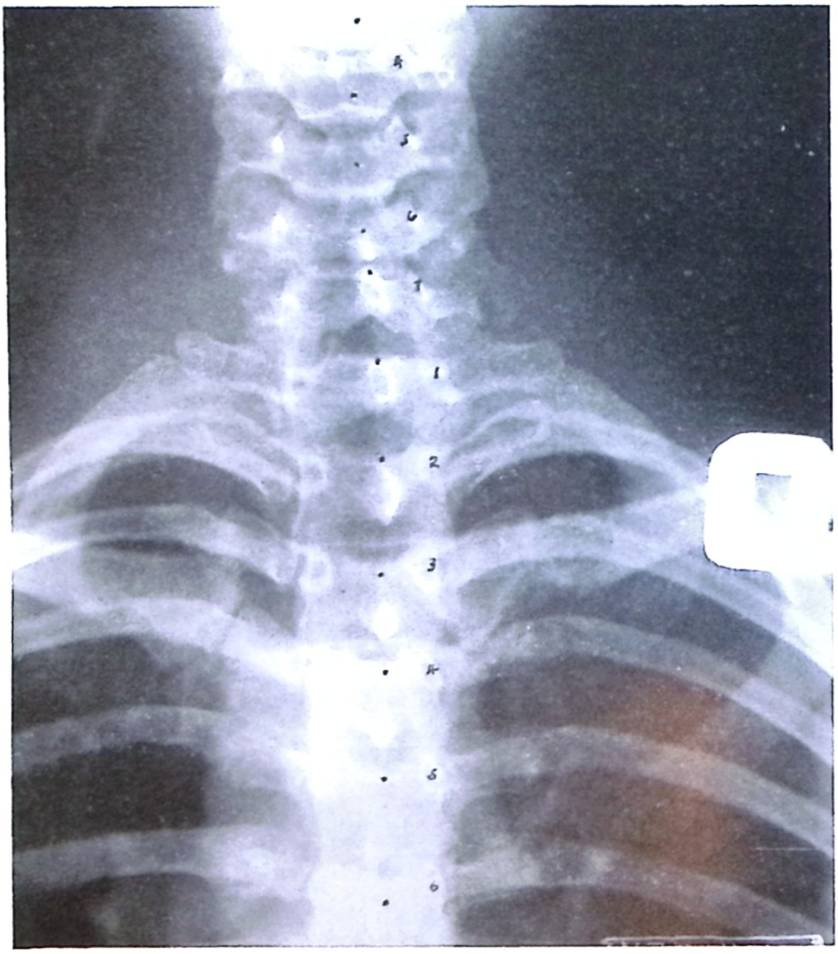


Figure No. 104

Lower Cervical and Upper Dorsal (L.C.U.D.)
AP View—2nd Section

Figure No. 105

Lower Dorsal (L.D.)—AP View (3rd Section)

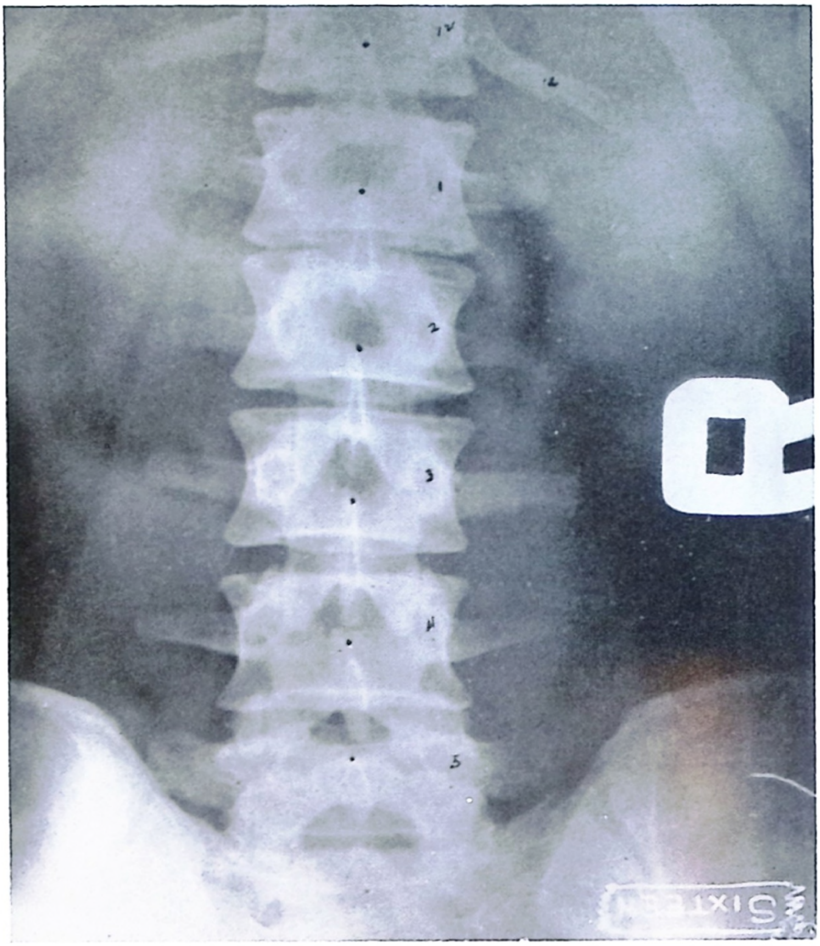


Figure No. 106
Lumbar—AP View (4th Section)

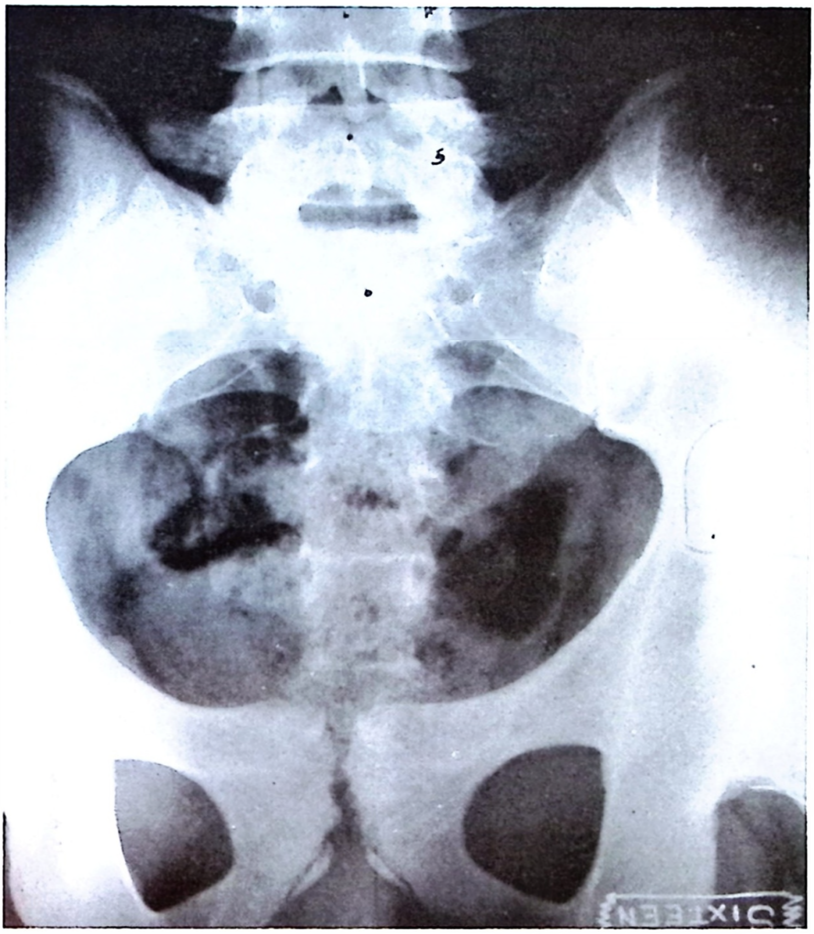


Figure No. 107

Sacrum and Coccyx (AP View) 5th Section

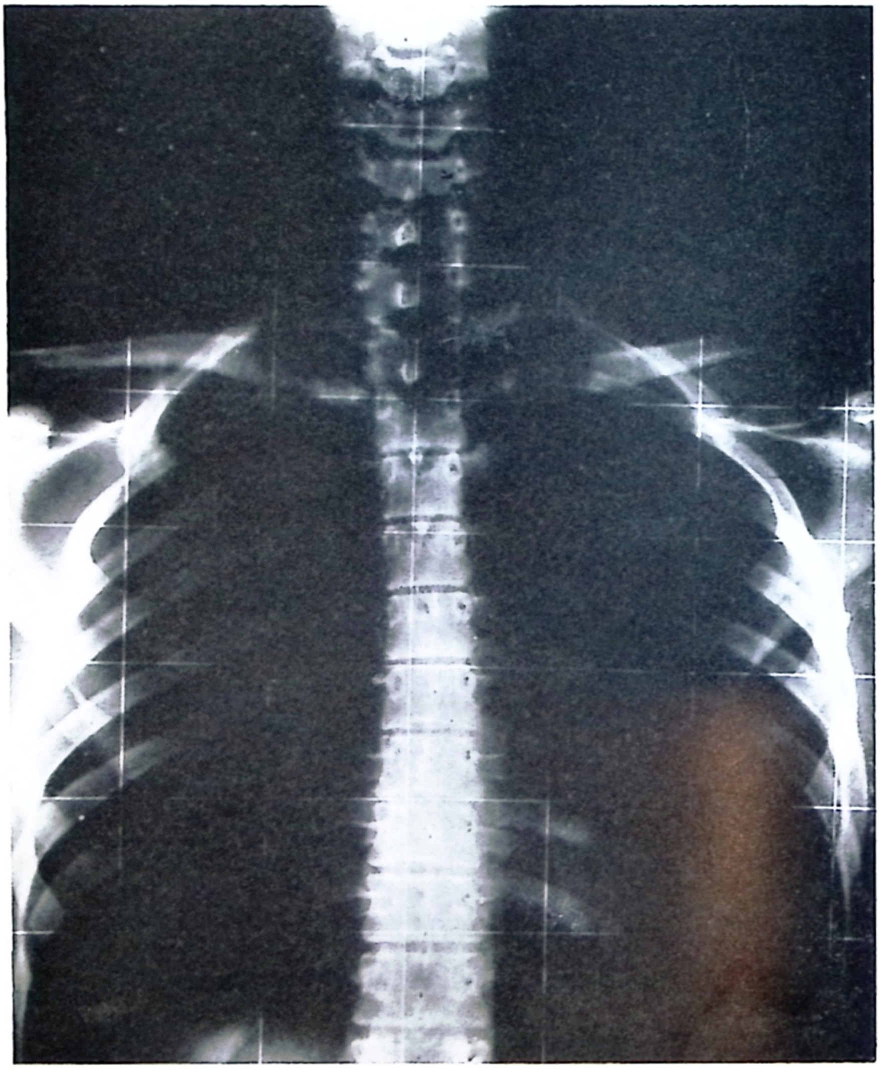


Figure No. 108
Cervical dorsal—14x17—AP view

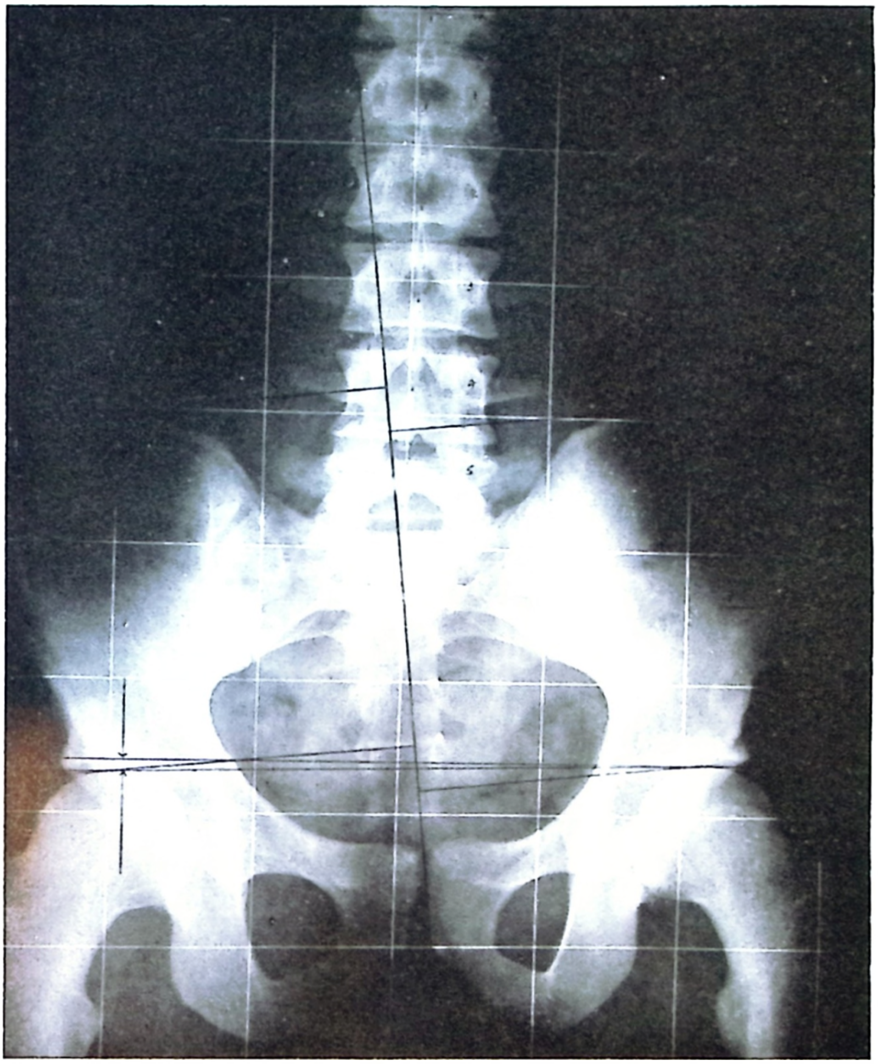


Figure No. 109
Lumbo pelvis—14x17—AP view

CHAPTER 33

Summary

During the early 30's Dr. B. J. Palmer, to whom this book is dedicated, changed his system of teaching and practice from meric to a newer way which he now calls specific.

The change was made almost overnight, although he had been working on the idea for years. As a matter of fact, his father before him had labored along these lines. Therefore, the principle of atlas-axis specific in chiropractic is not new; yet its application may so be considered.

The entry of specific chiropractic played a very important part in spinography. It was realized that the spinograph was an absolute necessity, indispensable to the chiropractic profession. The errors in the approach to the spinograph, as well as palpation, were revealed and precision was then demanded in both spinography and chiropractic procedures. Not only was this true in placing the patient for the various spinographic views, but the films required more contrast and detail. Immediate and extensive campaigns on better spinographs began. Today, the quality and precision of spinal pictures are obviously unexcelled.

It is the writer's opinion that more thought should be given to innate adaptation, even when deciding the directions in the analysis. Usually the misalignments are adaptations and not subluxations. Misalignments are visible; subluxations are not.

Every action has an equal or opposite reaction. For instance, every small condyle usually articulates with a larger lateral mass; for every curve there is one in the opposite direction; for every curvature there is, or will be, a compensatory curvature below. What appears to be a point of interference may be one of adaptation. A good example is the ankylosed, or kyphosed or bumped spine. It must be understood that all leg deficiencies or rotated iliums are not producing interference. So when reading spinographs, make every effort to determine whether the misalignment is adaptative or one to be listed and adjusted.

Prior to the advent of upper cervical work, only the lateral and the anterior posterior natural views were taken to determine atlas-axis misalignments. Research evolved the taking of stereo diagonals, the vertex, base posterior, and the nasium views. The diagonals indicated the atlas did rotate abnormally—but it was difficult to accurately place the patient and to read the film from its particular angle. The vertex and base posterior proves the atlas did rotate abnormally in almost every case.

The procedure in taking these views was less difficult, and to determine a listing of the rotation was not so complicated. The nasium was made to verify the findings obtained from the A to P natural, relative to atlas laterality and its lateral tipping. Though the nasium view is valuable it does not suffice for the properly made A to P natural view. It could be said that the base posterior takes the place of the vertex. It is read the same but it is much easier to take. And, too, the base posterior is actually an anterior posterior view, whereas the vertex is a posterior anterior view.

Research not only proved the atlas did rotate in the misalignment, it also proved that when the atlas rotated, in some instances, the degree of anteriority was found to be much greater than the degree of rotation. This placed the posterior rotated transverse closer to an imaginary horizontal line through the base of the odontoid looking

at the base posterior view, than the anterior rotated transverse from the same imaginary line. This is referred to as a pivoted atlas. See Fig. No. 92.

Not until this particular time was it at least generally known that the axis was never completely analyzed. Only the spinous was listed for laterality and the body for posteriority or anterior tipping. It was then obvious the axis did misalign by pivoting. So it is true the analysis does not reveal its full significance until one knows how the vertebra moved to its letter listing position. The precisionally made spinograph is the only way of knowing how the vertebra moves.

As previously stated, it is a physical impossibility to consistently palpate correctly all the directions in the subluxation. Yet, it is necessary to palpate along with the spinographic analysis—which is an indispensable aid to the profession—not only for contacts, but to check your findings. So palpation is important even though it is not always dependable. Further, it behooves one to keep trying to improve their work because precisionally-made spinographs revealing detail pave the way for better analysis; while continuous study of the articulations and the mechanics in adjusting the misalignments always bring about greater results.

There are at least 30 entirely different mechanical aspects in the misalignment of atlas and axis. I presume if all the combinations in the degrees (°) of these directions were recorded, one could say there are some 200—or even more—existing. This makes each case an individual one. Although we do not attempt to measure these directions in degrees, we believe it is important to use the plus sign (+) to designate the greatest of these directions. Naturally, this should have first consideration in the adjustment to be given.

Anomalies and malpositions always seem to exist to some extent. This again makes each case an individual one. Even though fixation of the head is employed, the film usually

reveals some head rotation. A reliable head clamp should be used; and though it may increase the time of the procedure in placement, it will keep malpositions at a minimum.

There are many variations throughout the atlanto-axial area. The foramen magnum varies in width and contour. This makes each case an individual one. The width of the first neural ring is often found to be wider than the distance between particular points of the condyles. There is great variation in the width of the first and second neural rings. Condyles vary in width and depth, as do the lateral masses. The occiput is often found very irregular. This all renders each case an individual one with no basis for a mathematical solution common to all. And with a certain amount of distortion in all spinographs, that which might measure 3° may actually be less than 2° or even more than 3°.

Compensation in the analysis for the anomalies and malpositions can be carried out with some degree of success. But, of course, it is always better to retake the view for malpositions. To have the case return for retakes is often inconvenient, and sometimes impossible. So to know what happens to certain spaces and the appearance of certain articulations on the film when the head rotates or tilts laterally will permit one to compensate with some degree of assurance in the final analysis.

Experience has taught that the precisionally-made lateral, base posterior and A to P natural, make the best cervical spinographic set. It is sometimes necessary, however, to add the nasium view—and even stereos—to better visualize the situation. Don't hesitate to take other views if certain necessary points are not visible on any of the original films. You must at all times check and attempt to prove, by comparison, that your findings are correct.

The lateral cervical view is very important. It determines the posterior anterior curvatures, any posterior inferior condition of axis, the anterior superior or inferior atlas, and is most important to see anomalies, exostosis,

ankylosis, fractures or dislocations. People do walk around with broken necks. So be sure you have all the information possible before proceeding with the adjustment.

The A to P natural film offers more general information than any other spinographic view. It determines the position of axis in its pivots, its body in relation to the median line, and permits one to ordinarily work out the rotation of atlas and its sideslip by using the so-called point system. It determines lateral curvatures and head rotation, and is another angle from which to see anomalies, etc.

The base posterior, or vertex, proves atlas rotation and the relation of atlas to axis to determine atlas laterality on condyles. It is also another angle from which to visualize the many variations. The base posterior or vertex (preferably the base posterior) in combination with the A to P natural determines laterality quickly and—in the majority of cases—instantaneously, without comparing all the descriptive parts with one another.

There is no concrete point to prove atlas laterality when reading only the A to P regular view, for right atlases are found in left point wedges and vice-versa.

The nasium was originally planned simply as another view in cases where the point of wedge could not be determined—usually because of anomaly. It was evident, however, that this view added to the visibility of the condyles in the majority of cases. Although the nasium has merit and seems necessary in some instances—as do the stereos and, perhaps, the oblique view—it will not suffice for the precisionally-made regular anterior posterior cervical spinograph. Repeating: It is our opinion that the lateral, regular A to P natural and the base posterior, precisionally-made, is the ideal spinographic set, adding other views when necessary, such as in border-line cases or when much anomaly prevails.

Atlas-axis comparison, which has been mentioned above, is an accurate method of reading the upper cervicals. It proves atlas rotation and atlas laterality without the ne-

cessity of comparing all the descriptive parts which may be normal and otherwise, to determine the analysis.

The actual listing is determined quickly—a very important factor in the chiropractor's office. This system is simple, therefore easy to apply—and the percentage of accuracy is very high.

In fact, it all adds up to one of B. J.'s familiar quotations: "It's the simple things in life which count."

CHAPTER 34

QUESTIONS AND ANSWERS PERTAINING TO X-RAY TRANSFORMERS, CONTROLS, ETC.

Question—Can either the alternating or direct current be supplied for operating X-ray equipment?

Answer—Yes.

Question—Why does the direct current machine operate with less efficiency from the standpoint of output than the alternating current machine?

Answer—The output of the direct current machine is limited by the size of the rotary convertor.

Question—What is a rotary convertor?

Answer—It is a device to change direct current to alternating current.

Question—Why is it used?

Answer—A rotary convertor is essential when alternating current is not available because alternating current is necessary in the production of X-rays.

Question—What is the action of the rotary convertor?

Answer—Its speed is momentarily increased then decreased, with a corresponding voltage drop in the convertor.

Question—What is the usual voltage (direct) used in operating the X-ray machine?

Answer—110 or 220 volts. Preferably 220.

Question—What should be the size of the line wire from the transformer to the X-ray machine.

Answer—6-8, depending on the size of the unit.

Question—If lead wires were too small what would be the result?

Answer—A drop in current and hence the maximum output of the machine would be impossible.

Question—What else governs the size of the lead wire?

Answer—The length of its span.

Question—How would you determine the correct size of the lead wires?

Answer—This information should come from the X-ray manufacturer or perhaps your Power and Light Company.

Question—Which type of current is more commonly used for X-ray work?

Answer—Alternating current.

Question—Why?
Answer—Because there is mcre alternating than direct current manufactured, and also the peak of AC is higher than DC.

Question—What is the usual voltage supplied the outside transformer or from where you get your source of supply?
Answer—220.

Question—What is the use of a pole transformer?
Answer—To step down the high voltage to a value which can be safely used.

Question—Should other power supplies be drawn from the same transformer which supplies the X-ray machine?
Answer—Not advisable.

Question—What would be the result?
Answer—A drop or variation in current.

Question—Is there anything to overcome this?
Answer—Yes, to a certain extent.

Question—What?
Answer—A stabilizer.

Question—How is the machine connected to the outside power line?
Answer—By a main fuse block and switch (safety type).

Question—What size fuse should be used?
Answer—30 Amperes for small units; 60 Amperes for the larger units.

Question—Where should this switch be placed?
Answer—Near the machine.

Question—Why?
Answer—So the operator standing at his machine can conveniently engage or disengage the main line switch.

Question—What is known as the control board or working panel?
Answer—That part of the machine which suspends the levers, knobs, and dials for the operator's use.

Question—What is the ordinary number of dials and controls on such a panel?
Answer—Modern up-to-date equipment usually has one or two pilot lights for reading meters and a small switch controlling same, a milliampere meter, a kilo-volt-meter, a pre-reading volt meter, an X-ray switch, either lever or button in action, a pre-reading volt button, a filament control button, a bucky release button, in the larger types of machines a polarity indicator, and a main switch when using equipment of the mechanical rectifying type. A plug is either constructed in the side of the machine or in some cases it is found on the panel to plug in an automatic timer, the foot switch, or bucky release cable.

Question—What is the purpose of the main-line wall switch?
Answer—To supply the machine with current.

Question—What is the purpose of the X-ray switch?
Answer—To allow the high tension current to pass thru the tube in the production of X-rays.

Question—What is the purpose of a foot switch?
Answer—To operate the equipment so the operator may use his hands for other purposes such as holding the patient. It is par-

ticularly helpful in fluoroscopic work, where it is necessary to hold and move the fluoroscopic screen about.

Question—What type of switch should be used in the machine?
Answer—An oil type to prevent arcing.

Question—What is the purpose of the automatic timer?
Answer—For correctly timing the exposures, particularly when fractional seconds are used. Also, it is then possible to make duplicate exposures.

Question—What is the purpose of the motor switch?
Answer—It is to revolve, start, and stop the synchronous motor or rotary convertor.

Question—What is the synchronous motor?
Answer—One that is always timed with the incoming current.

Question—Why is a synchronous motor used?
Answer—It is the only alternating type motor that can be depended upon to revolve the rectifying switch in such a manner that the switch will always be in a position coinciding with each alternation of the alternating wave.

Question—What usually is the cause of a synchronous motor being out of time?
Answer—Bearings too tight, in need of oil, or a defective motor; and sometimes frequency above normal.

Question—How is this detected?
Answer—By the polarity indicator swinging from side to side, or a peculiar sound of the switch or the motor.

Question—What is the auto transformer?
Answer—It is a device with numerous voltage steps—used in connection with the auto transformer lever for varying the primary voltage delivered to the high tension transformer.

Question—What voltage is usually delivered from the auto transformer?
Answer—Approximately 35 to 220.

Question—Will the auto transformer act as a stabilizer?
Answer—No.

Question—Do auto transformers have only one control?
Answer—Some have two for finer gradation but the more modern equipment has one to simplify the operation.

Question—Should the auto transformer steps be uniform?
Answer—Yes.

Question—What is a rheostat?
Answer—A device of resistance to absorb some of the power delivered to the step-up transformer.

Question—Is this a part of the modern equipment?
Answer—No. Rheostats with control levers, as a part of the working panel, have become more or less obsolete.

Question—Is the rheostat as efficient as the auto transformer?
Answer—No.

Question—What is a pre-reading volt meter?
Answer—A device to measure the voltage, delivered to the auto transformer before the X-ray switch is engaged.

Question—Why is it used?
Answer—To pre-determine KVP value for duplication.

Question—How does it operate?
Answer—It indicates the voltage of each auto transformer step or button.

Question—Could a volt meter be used in its place?
Answer—No.

Question—Why?
Answer—Because a volt meter only indicates the main line voltage.

Question—What is a polarity indicator?
Answer—A device to indicate the direction of the flow of the current.

Question—Is such an instrument necessary when using both types of current?
Answer—No. It is not necessary with alternating current units or with self-rectification equipment.

Question—Why isn't it necessary with a self-rectification unit?
Answer—Because the tube itself is self-rectifying—up to a very high degree of heat.

Question—What is a step-up transformer?
Answer—One that transforms a fairly low, primary voltage and a high primary current to a high secondary voltage and a proportionately lower secondary current.

Question—Are high tension transformers generally oil-immersed?
Answer—Yes.

Question—Why?
Answer—For better insulation.

Question—Should the oil in the step-up high tension transformer be of a certain level?
Answer—Yes, the level to be determined by the manufacturer. Usually the oil should be well over the plates and the core of the transformers.

Question—What is transformer core?
Answer—It is composed of laminated, transformer steel which forms a path for the magnetic line of force, generated by the primary windings.

Question—How many types of cores are there?
Answer—Open and closed.

Question—What is the open type?
Answer—A type which has an open core through its primary and secondary windings.

Question—What is the closed type?
Answer—A type which has an open core through its primary and secondary windings linked by a closed iron core.

Question—What type is ordinarily used in X-ray?
Answer—Closed type.

Question—Why?
Answer—The efficiency of the closed type is greater.

Question—What is a rectifier?
Answer—A device used to change alternating current into a pulsating direct current.

Question—What types are in use?
Answer—The cross arm and the disc type, valve tubes, or self-rectifying tube.

Question—Which is the better type?
Answer—Valve type.

Question—Why?
Answer—It rectifies a greater percentage of the wave.

Question—What is meant by the rectifier being in or out of phase; in other words, out of time?
Answer—It is in phase or in time when it is set to rectify the maximum amount of the wave. Otherwise it is out of time. In this event there is present usually a long lead spark—sometimes spoken of as the lag spark or the low current valves.

Question—What is usually the result of such a spark?
Answer—A loss of energy delivered to the tube and a loss of X-ray output.

Question—What is the milliampere meter?
Answer—An instrument to indicate the amount of current passing through the tube.

Question—What is a stabilizer?
Answer—A device to stabilize or control the milliamperes through the tube.

Question—Will the filament current or Kilo-Volt-Peak variation have any effect on the stabilizer?
Answer—No, within operating limits.

Question—Who invented the stabilizer?
Answer—William Kersley.

Question—Is the stabilizer used for all phases of radiographic work?
Answer—Yes, when operating under 100 milliamperes.

Question—Does the stabilizer have any value if the filament circuit is constant?
Answer—Yes, it eliminates tube testing.

Question—How?
Answer—The stabilizer, once set, will always allow for the same amount of milliamperes.

Question—Will the stabilizer operate on self-rectification?
Answer—Yes, but of a different design incorporating the same principles.

Question—Will the stabilizer operate with auto-transformer and rheostat controls?
Answer—Yes.

Question—Will the stabilizer increase the milliampere output?
Answer—No, not above the capacity of the unit.

Question—Will the stabilizer have any effect upon the life of the tube?
Answer—Yes, it should increase the life of the tube because it eliminates tube testing.

Question—What is an overhead system?
Answer—Usually a system of tubular aerial, with proper wiring inside, for the purpose of transforming the current from the machine overhead down to the tube.

Question—Do all X-ray machines employ tubular aerials?
Answer—No. Usually the larger mechanical rectifying units do; the small rectifying units as a rule do not.

Question—Why is tubing used for aerials?
Answer—Because less corrosion forms on the tubing than on the wire itself.

Question—What is the purpose of cord reels?
Answer—To deliver the high tension and filament circuit from the aerial to the tube or from the top of the mast to the tube.

Question—What main line voltage is required to operate the filament circuit?
Answer—Can be 110 or 220 volts; usually 220 volts is stepped down from the main transformer. When only 110 volts is supplied then a small or step-down transformer is used.

QUESTIONS AND ANSWERS PERTAINING TO THE DARKROOM

Question—How large a darkroom should be constructed?
Answer—Of sufficient size in which to do your work.

Question—Should it be ventilated?
Answer—Yes.

Question—Why?
Answer—To insure the health of one doing the developing and to assure faster drying of films.

Question—What should be the darkroom equipment?
Answer—

a. Suitable developing and fixing tank.
b. Tank for rinsing (should be placed between the solution tanks).
c. Washing tank (supplied with running water).
d. Loading bench (should be as far from solution tanks as possible).
e. Film cabinet—lead lined (for storing unexposed films).
f. Drying rack (more conveniently located over wash tank).
g. Rack for suspending developing hangers (more conveniently located over loading bench).
h. Shelf over solution tank (necessary for the storage of extra solution in brown bottles).
i. Earthen crock or porcelain pail, sufficiently large to mix developer.
j. Earthen crock or porcelain pail, sufficiently large to mix fixer.
k. Ebonite container for X-ray hardener.
l. Two wooden paddles for the mixing of solutions.
m. Safelight, on shelf over developer.
n. Illuminator, on shelf over hypo.
o. Darkroom timer.
p. Safelight over the loading bench.
q. Indirect safelight, on ceiling in center of the room.
r. Bright light over door with switch conveniently located—also switch for indirect safelight.
s. Spigots, for hot and cold water, if same is available.
t. Electric fan for quick drying of films.
u. Gallon glass measure.
v. Covers for solution tanks.
w. Solution thermometer.
x. Trimmer (for trimming films).
y. Wastebasket.

z. Sufficient number of developing hangers (8x10, 14x17, and 14x36 if same is necessary—also dental clips if dental work is being done).

Question—Should darkroom exclude all ordinary light?

Answer—Yes, also light through keyholes, as well as around doors and windows.

Question—Where should the lights be placed in the darkroom?

Answer—The ordinary light over the door; an indirect safe light on the ceiling in the center of the room, ordinary safelight is above developer and loading bench, illuminator over hypo tank.

Question—Should lights have switches?

Answer—Yes, switches for bright light and indirect ceiling light conveniently located near doorway. Other safelights may be plugged into electric sockets.

Question—Why should the bright light be excluded?

Answer—Such light will fog the unexposed films—those being developed.

Question—How can ordinary light fog be detected?

Answer—By black streaks on the developed film, either around its edges, or across the film. If the entire film was exposed to ordinary light, it would develop a jet black.

Question—Why the illuminator over the hypo tank?

Answer—For the purpose of analyzing wet films.

Question—What color safelight shades may be used?

Answer—Red or green.

Question—Which is better?

Answer—Matter of opinion.

Question—Are all safelights safe?

Answer—No.

Question—What method is used to determine whether or not they are safe?

Answer—Cut off a small piece of unexposed film under the safe light. Hold a key or a coin in front and against it. Hold same in front of safelight, four to six inches away, for 20-30 seconds. Then develop this film, rinse and fix. If object develops on the film the light is not safe. If it does not develop on the film the light is safe.

Question—How would you make the light safe?

Answer—By putting a smaller bulb and repeating the test, by using red or green paper in front of the shade, or by placing a piece of unexposed film in back of the shade or colored glass. It is understood that all the safelight possible is an asset to any darkroom, but the light must be safe.

Question—What is the proper wall and ceiling finish for the darkroom?

Answer—Either tan or some other light tone.

Question—What are static marks?

Answer—Abrasions of fine black hair lines on the developed film. These sometimes appear as a fine network of black lines or crescents.

Question—What is the cause of these lines?

Answer—Friction, caused by drawing the film's emulsion over an object.

Question—What causes clear or transparent spots on the developed film?

Answer—They may be caused either by kinking or bending the undeveloped film, inferior screens, foreign bodies on the films, or air bubbles in developing.

Question—What causes greasy developed films?

Answer—Insufficient washing and inferior hypo or fixer.

Question—What causes a reddish stain?

Answer—Inferior grade of hypo.

Question—How does overdevelopment appear on the film?

Answer—A muddy fog.

Question—How do you know when films are over, under, or correctly exposed when developing?

Answer—On correctly exposed films the image will begin to appear in approximately one minute and a half, providing, of course, that the solution is of the proper strength and temperature.

Question—How would you know when it is of the proper strength?

Answer—By the number of films developed and the color of the developer.

Question—What should be the color of proper developer?

Answer—Clear, very light amber.

Question—What is the color of worn-out developer?

Answer—Dark amber, muddy, and riley.

Question—What should be the proper temperature of the solution?

Answer—65° to 68° F.

Question—How soon will the image of the overexposed film appear in the development?

Answer—The overexposed film will develop much sooner than one minute and a half.

Question—What about the development of the underexposed film?

Answer—The underexposed film is naturally slow in developing and, of course, will not bring the image out 100 per cent.

Question—How long should films develop?

Answer—A full six minutes, if correctly exposed. The last minute adds to the detail and contrast of the film.

Question—How should the correctly exposed and developed film appear when dry?

Answer—Black and shiny, with contrast and detail. When holding the film below your eyes with the ordinary light striking it at an angle you should be able to detect the black lines which are the outlines of the osseous structure. Film should dry smooth, even and free from dust. Dust will cause the film to dry rough.

Question—What is the function of the developer?

Answer—Developing solution oxidizes the silver bromide of the emulsion which has been energized by the exposure.

Question—What chemicals are ordinarily used in the developer?

Answer—Metol, or elon, hydrochinon, sodium sulphite, sodium carbonate, potassium bromide, and always distilled water.

Question—What is the purpose of each of the chemicals?

Answer—Metol is an oxidizing agent giving detail and also definition to the film. Hydrochinon is also an oxidizing agent which adds contrast to the film. Sodium sulphite is a preservative

while sodium carbonate, an alkali, opens the pores of the emulsion and accelerates the developing. Potassium bromide retards too rapid development. Distilled water acts as a solvent and holds the chemicals together.

Question—Is it better to weigh and mix your own solution or buy the ingredients in powder or liquid form already mixed?

Answer—Either of the latter is preferable.

Question—What type of developer should be used?

Answer—Perhaps better results are obtained by using the same brand of developer as are the X-ray films. In other words, if you use a certain brand of film use that brand of developer for that brand of developer is particularly prepared for that type of film.

Question—What should be the temperature of distilled water for mixing?

Answer—90° to 100° F.

Question—Should new developer be used immediately?

Answer—It can be, but better results are obtained if the solution is allowed to stand for a few hours before using.

Question—Should new developer be added to old in the tank?

Answer—No. but very often this procedure takes place.

Question—Why?

Answer—Because it promotes deterioration.

Question—What is usually the object of adding new to old?

Answer—To fill the solution tank so that the films may be entirely submerged.

Question—What causes the tank solution to lower?

Answer—Usually the removal of films—not allowing the solution to drip back into the tank, plus some amount of film emulsion absorption.

Question—Will extra solution keep?

Answer—Yes, if kept in brown bottles.

Question—What effect will the brown bottle have?

Answer—Keeps the air and light from causing oxidation.

Question—Should the solution be stirred before being used?

Answer—Yes, slightly, to assure even temperature.

Question—How should the films be placed in the developer?

Answer—By quickly submerging and briskly shaking them. Incidentally, it is advisable to unload and place in the hangers the complete set of films if possible, submerging the entire number in the developer at the same time.

Question—What will this prevent?

Answer—An irregular development, also prevents air bubbles from forming on the negative.

Question—What will irregular development cause?

Answer—Possible streaks on the film.

Question—What will air bubbles cause?

Answer—Blisters on the developed film.

Question—What will an oxidized developer produce?

Answer—Slow developing, cause stains, and lessen density and contrast.

Question—What two methods are used in developing?

Answer—Tank and tray methods.

Question—Which one is proper?
Answer—Better results are obtained with the tank method.

Question—What prolongs the life of the developer?
Answer—Keeping the solution covered, maintaining an even temperature, and of course, the amount of films developed.

Question—Can an underexposed film be fully developed?
Answer—No.

Question—Can an underdeveloped but correctly exposed film be further developed?
Answer—Yes.

Question—How?
Answer—By an intensifying solution, but this is not practical.

Question—Can an overexposed film be made readable?
Answer—Yes, by reducing the developing time. This causes a great deal of attention during development to be sure that the film is not too black. One will perhaps have to develop the film in front of a safelight before completing the development. A correctly exposed film may be viewed only once or twice during the six minute developing.

Question—Can an overexposed and an overdeveloped film be made readable?
Answer—Yes.

Question—How?
Answer—By using a reducing solution. But perhaps it would be just as cheap and convenient to take the film over.

Question—How may one determine the six minute period for development?
Answer—By noting the luminous dial of the darkroom timer when development is begun. Then remove the film at the end of six minutes either by re-examining the clock or by using a timer with an alarm.

Question—How does one use the safelight to determine the degree of development of the image on the film?
Answer—Not by holding the film directly in front of the safelight but at an angle, tipping the top of the film slightly away from you, looking between the film and the safelight. When the film is properly developed you will note, using this method, that the outlines show quite sharp and the less denser areas stand out light—to a sort of yellow similar to the ordinary color of the undeveloped emulsion.

Question—What is the proper method of rinsing?
Answer—Use the small rinsing tank of running water between the solution tanks, then briskly swish the film about keeping it completely submerged for about one second.

Question—What will this do?
Answer—Wash off most of the developer left on the face of the film and saves the hypo.

Question—What should be the temperature of the rinse water?
Answer—As near the solution temperature as possible.

Question—What is another name for hypo?
Answer—Fixer.

Question—What is the function of the hypo?
Answer—To dissolve the unexposed and undeveloped silver bromide—leaving a permanent silver oxide image.

Question—How long should films fix or remain in the hypo?
Answer—15 minutes in a solution of the proper strength and temperature.

Question—Can they be taken out of the solution in front of a bright light within five minutes?
Answer—Yes, even after two or three minutes of fixation but they must be replaced for a total of 15 minutes.

Question—What is the result of an improperly fixed film?
Answer—Stains and also the film will fade.

Question—What are the ordinary chemicals used in the hypo solution?
Answer—Though there are several fixing baths on the market the following ingredients make a good workable solution: Sodium hydrosulphite or hypo crystals, sodium sulphite, chrom alum, sulphuric acid, and water.

Question—What is the action of each of these ingredients?
Answer—Hypo crystals act as a solvent for the silver bromide since they dissolve both the unexposed and undeveloped silver bromide particles. Sodium sulphite is a preservative. Chrom alum is a hardener and the sulphuric acid prevents the solution from becoming alkaline in nature, and stops development.

Question—Is it necessary to use distilled water in the hypo solution?
Answer—No.

Question—How long should the hypo solution last?
Answer—It depends upon the temperature and the amount of films fixed.

Question—How would you know when the solution has deteriorated?
Answer—By the delayed manner in which it clears the film and by its color.

Question—What is the color of deteriorated solution?
Answer—A light greenish-blue.

Question—Is it advisable to add new hypo to old?
Answer—Yes, as long as solution hasn't changed its original color.

Question—For what purpose would one add new to old?
Answer—To fill the tank so as to completely submerge the films.

Question—What would be the correct hypo temperature?
Answer—Same as the developer?

Question—What would be the result of cold hypo?
Answer—Retards the fixation.

Question—What should be the temperature of the wash water?
Answer—Not over 70° F.

Question—How long should they wash?
Answer—30 minutes in proper temperature.

Question—If wash water is too warm what is the procedure?
Answer—There are various hardening solutions to be used, but perhaps one that gets as good results as any, is a hardener of 6 parts water to 1 part of formaldehyde—used between the hypo or fixer and the wash water.

Question—How long should films remain in the hardener?
Answer—Not more than two minutes.

Question—How long should films then wash?
Answer—30 minutes.

Question—If water is slightly too warm and hardener is not used how long can they wash?
Answer—Not more than 15 minutes and then one should swish them about in the wash water frequently.

Question—What is the result of wash water being too warm?
Answer—Softens the emulsion of the film base.

Question—What is the result?
Answer—A quite porous appearing film—the emulsion sliding or shifting on the base and perhaps completely sliding off.

Question—What is the required time for drying?
Answer—This depends entirely upon the atmospheric conditions. Under ordinary conditions, with the use of a fan circulating the air, a film may be dried in approximately 1½ hours.

Question—How can films be dried quickly?
Answer—By the use of an electric fan or a solution of grain alcohol.

Question—Which is better?
Answer—An electric fan, as the alcohol sometimes causes the film to dry streaked. However, films should be dried in a warm place —free from dust and dirt.

Question—How do secondary rays affect the film?
Answer—They cause what is known as secondary fog and a dark grayish dirty color appears on the developed film.

Question—How can films be tested for ordinary light, chemical, or secondary fog?
Answer—By developing and fixing any one, or all of the suspected films without the usual X-ray exposure.

Question—How should unexposed films be handled in the darkroom?
Answer—Only by their extreme edges, otherwise finger prints will develop on the film.

Question—Why is it necessary to handle films with perfectly dry hands?
Answer—The edge of film gets sticky and when placed in the cassette between the screens will very often adhere to the screens under pressure.

Question—What make of film is better for radiographic purposes?
Answer—That is a matter of opinion as some films are slightly speedier while others promote more contrast. Any standard make is a good film.

Question—What is a cassette?
Answer—A fixture for keeping the film lightproof during exposure.

Question—Should one keep the cassettes always loaded?
Answer—Not for any great length of time. If cassettes are to be kept unloaded then a clean piece of white tissue paper or cardboard should separate the screens.

Question—How should the exposed film be kept?
Answer—Always in a steel filing cabinet; though the standard film of today is not combustible, it is inflammable.

Question—What is the better make of cassettes?

Answer—This is a matter of opinion, any standard make may be used.

Question—How are cassettes faced?

Answer—By aluminum or bakelite.

Question—Which is better?

Answer—Technically, the bakelite offers the least resistance; however, there is so little difference that one would hardly notice it. Incidentally, the price of the two is usually the same.

Question—What is the purpose of the intensifying screens?

Answer—To shorten the exposure and add to the detail of the film.

Question—What is the screen composed of?

Answer—A piece of thin cardboard—usually white, coated with small particles of calcium tungstate.

Question—What is its action?

Answer—These crystals fluoresce, under the influence of X-rays.

Question—Will the tungsten crystals deteriorate?

Answer—No.

Question—How are they used in the emulsion?

Answer—They are suspended by what is called a binder and usually distributed within the emulsion.

Question—Are there various grades of binder?

Answer—Yes.

Question—What grade should be used?

Answer—The very best, as cheap grade will turn a screen yellow.

Question—How is the fluorescence given off this screen governed?

Answer—By the purity of the crystals.

Question—Are the rays given off by the intensifying screens as effective as the X-ray?

Answer—No. They are said to be blue, violet, and of longer wave lengths, so naturally there is less penetration.

Question—How will solution spots affect the intensifying screens?

Answer—If allowed to dry they will produce yellow spots on the screen. If not dry, and the screens contact one another for only a short length of time, the two screens will adhere to one another and, as they are taken apart, the emulsion is very often broken.

Question—Can the wet solution spots be removed?

Answer—Yes, by the use of a tuft of cotton and hydrogen peroxide. The area is slightly rinsed and dried with a tuft of cotton.

Question—Can the dried solution spots be removed?

Answer—No, not without injury to the screen.

Question—Should the screens be removed from the cassette for cleaning?

Answer—No.

Question—How are screens usually cleaned?

Answer—With a tuft of cotton, Ivory soap, and lukewarm water, thoroughly rinse the soap from the screens, using a tuft of cotton for drying and then place screens in the sun for further drying. The sun also tends to bleach screens. On Rodelin screens use carbon tetrachloride.

Question—How are the screens adhered to the cassette?
Answer—By a small amount of adhesion at the extreme corners.

Question—How is the cassette made lightproof?
Answer—By employing a piece of felt, slightly larger than the cassette cover itself. When the cassette cover is closed the felt forces its way between the cover and the frame of the cassette making it lightproof. It is sometimes necessary to replace this felt to prevent ordinary light from reaching the film.

Question—How does one know whether the cassette is leaking light?
Answer—By the black streak around the border of the developed film.

Question—What are dead spots?
Answer—Areas on the film which lack the same amount of detail and contrast.

Question—How are they produced?
Answer—Either by a poor contact of film and screen, or by a shifting, causing a density of tungsten crystals.

Question—How does this happen?
Answer—First, too much adhesion raising the corners of the screens or by a lack of elasticity of binder causing the crystals to move out.

Question—What causes light specks on the developed film?
Answer—Usually dirt or foreign bodies—collecting on the screen surface.

Question—How could one prevent it?
Answer—By brushing out the cassette with a camel hair brush.

Question—Are all screens the same speed?
Answer—No.

Question—Why?
Answer—Because they are manufactured in slow, medium, fast, and extra fast.

Question—Which is the better for radiographic purposes?
Answer—Though the fast is more generally used, perhaps the medium will give the best definition but an extension of exposure time is necessary. This is not generally used because of the possibility of motion.

Question—What is meant by screen speed?
Answer—This is the relative amount of X-ray exposure required, between the use of a film with the intensifying screens and without. If a given technique requires one second to obtain a radiograph, with intensifying screens, and five seconds exposure when screens are not used—then the ratio is 5 to 1.

Question—How can the speed of a screen be increased?
Answer—By increasing the size of the tungsten crystals up to a certain point.

Question—How can a pair of screens be tested for speed?
Answer—Make a correct exposure, using one second of time with corresponding machine technicalities. Develop the film in the usual manner. Then make several exposures of films without the screens until a like density is obtained. Count the number of exposures without screens and you will have the ratio to one.

Question—What is meant by double screen technique?
Answer—Employing the use of two screens.

Question—How is the film used with screens?
Answer—The film is placed between the two screens.

Question—Why are two screens used?
Answer—Because films are coated on both sides of the base, thus permitting the two screens to work on both sides of the coating.

Question—What are the important points to be considered in a screen?
Answer—Speed, grain, lag, uniformity, contrast, and cleanability.

Question—What causes screen grain?
Answer—Usually the tungsten crystals are too large.

Question—What promotes uniformity?
Answer—The general distribution of tungsten crystals.

Question—What is lag?
Answer—Lag is an afterglow of the fluorescence. In other words, the screens continue to fluoresce after the X-ray exposure has ceased.

Question—What causes lag?
Answer—An inferior grade of calcium tungstate.

Question—How would one test for lag?
Answer—Expose an unloaded cassette (but with screens) with a coin, or a key as the object. Remove cassette to the darkroom and load with film. Leave the film in contact with the screens for five minutes. Then remove the film, develop in the usual manner and if an afterglow is present or the screens are laggy, the object will reveal an outline on the film.

Question—Is this lag detrimental?
Answer—Yes.

Question—Why?
Answer—It may give the film a double exposure appearance.

Question—What is the result of poor film and screen contact?
Answer—A lack of definition and a haziness, or fuzziness of outlines.

Question—What is meant by a cleanable screen?
Answer—A screen that may be washed removing the dust particles without injury to the screen.

Question—Are all screens cleanable?
Answer—No.

Question—What is the base of the X-ray film?
Answer—Cellulose acetate.

Question—Should the same size films and screens be used together?
Answer—Yes.

Question—Why?
Answer—If a film smaller than the screen is used there is a possibility of scratching the screen when attempting to remove the film.

Question—Should cassettes be loaded in the dark?
Answer—Yes, absolutely.

Question—What are the ingredients of the binder?
Answer—A gelatin process whose ingredients are secretly known.

Question—Are single screens used?
Answer—Generally no. The modern and up-to-date method is the double screen.

Question—Will developing hangers wear out?
Answer—Yes.

Question—Why?
Answer—The solution forms a corrosion on the hangers which takes out the temper of the clip springs.

Question—Can this be overcome?
Answer—Yes, to a certain extent, by occasionally soaking the hangers in acetic acid, then washing them.

QUESTIONS AND ANSWERS PERTAINING TO THE BUCKY DIAPHRAGM

Question—What is a Bucky diaphragm?
Answer—A device, with movable grid, used in radiographic work to eliminate the greater percentage of secondary and angling rays.

Question—What is the result of secondary radiation on the film?
Answer—It fogs the film.

Question—Who developed the Bucky diaphragm?
Answer—Drs. Potter and Bucky.

Question—What types of Buckys are manufactured?
Answer—Flat and curved types.

Question—Which is the better?
Answer—The flat is more universally accepted.

Question—In what sizes are they made?
Answer—At least three sizes: 8x10, 14x17, 14x36, also larger.

Question—Will the Bucky work horizontally or vertically?
Answer—The modern ones will work either way.

Question—What is the percentage of such radiation eliminated?
Answer—It is said to be from 75 to 90 per cent.

Question—For what class of work is the Bucky diaphragm used?
Answer—Practically all types of radiographic work, except for the extremities and the chest.

Question—What are the working parts of the Bucky diaphragm?
Answer—Movable grid, consisting of strips of lead and wood; a plunger and cylinder or motor for the purpose of making the grid travel synchronously with the exposure time; a lever for drawing the grid to one side; a release, either to be worked manually or electrically, to start grid in motion; a tray for supporting cassettes; a timing device, for regulating the travel of the grid; an electric bell, to note the starting or stopping of grid or both; a supporting frame; a tipping or angling device, an aluminum or bakelite top; proper springs, and an immobilizing device.

Question—Will the Bucky operate with instantaneous technique?
Answer—Modern ones will.

Question—Why?
Answer—Because with instantaneous technique, grid lines will appear on the film.

Question—What is the minimum amount of time to be used with the Bucky?

Answer—Approximately one second.

Question—What causes grid lines to appear on the film?

Answer—Shortening an exposure, a grid not in motion, one not traveling in synchronism, vibration, not in position, or not in proper location with tube or rays that are being driven diagonally toward the Bucky.

Question—Is the Bucky diaphragm a necessity?

Answer—Yes. Either the movable or stationary grid.

Question—Why?

Answer—It eliminates fog and brings out the lines of demarcation.

Question—Why are lead and wood strips used in a grid?

Answer—Lead is opaque and will absorb the secondary and angling rays which strike it.

Question—What is the purpose of the wood?

Answer—It allows the more direct rays to penetrate.

Question—Of what thickness are the lead and wood strips?

Answer—The wood strips are approximately 1/16 of an inch thick and the length of the grid. The lead strips are 1/5 to 1/800 of an inch thick and the length of the grid.

Question—How are they mounted in the grid?

Answer—First a strip of wood and then a strip of lead, then when the grid is traveling with its center directly beneath the object, the direct rays are practically unobstructed by the lead, the angling rays striking the lead either towards the top or the bottom of the lead.

Question—What does grid ratio mean?

Answer—It means the difference between the thickness of the lead and the wood.

Question—What is the usual ratio?

Answer—Approximately 6 to 1.

Question—Why are lead strips so thin?

Answer—To permit more energy to reach the film.

Question—Will any type of wood do in making the wood strips?

Answer—No, only certain kinds which have no pitch.

Question—What is the depth of the grid?

Answer—Approximately one-half inch.

Question—Why is it necessary that the depth of the grid be as small as possible?

Answer—The shorter the distance between the patient and the film, the less the distortion, and the better the detail.

Question—Why are grids various sizes?

Answer—To cover various size films.

Question—Why should the grid be approximately three inches wider than the film?

Answer—Because the grid travels approximately three inches and it is necessary that the entire film area be completely covered during the exposure.

Question—What was the first type grid made?

Answer—Curved.

Question—Why was a flat grid then made?
Answer—To lessen the size of the Bucky and make it possible for the object to be near the film.
Question—What types of cylinders are used?
Answer—Oil and air, operated by either springs or electric motor.
Question—Which is the better cylinder?
Answer—Oil.
Question—How is it constructed?
Answer—A certain size cylinder and piston is used making two complete chambers in the piston. The head of the piston has a certain number of various size holes or a slotted hole the size of several various size holes or perhaps more commonly called a vent. Then a plate fits tightly in front of the piston head which is so constructed that by turning the Bucky timer button these holes or slots or vent open and close allowing more oil or air to get through them regulating the time of complete travel of piston or the time of complete travel of grid. In other words the oil moving from one chamber to the other would naturally change the speed of the piston or plunger.
Question—Is it possible to find air bubbles in the oil chamber?
Answer—Yes.
Question—What is the result?
Answer—A jerking or irregular travel of grid which may result in grid lines appearing on the film.
Question—Can this condition be remedied?
Answer—Yes.
Question—How?
Answer—By pulling out the plunger rod and releasing it several times.
Question—What would be the result if the grid did not begin its travel before the exposure and yet continued to travel after the exposure?
Answer—Grid lines on the film.
Question—What is the purpose of the cassette carrier?
Answer—To support the cassette in the Bucky diaphragm.
Question—What is the purpose of the aluminum or bakelite top?
Answer—To support the patient and to cause less resistance to the X-rays.
Question—What is the function of the immobilization device?
Answer—To hold the patient still during exposures.
Question—What does such a device consist of?
Answer—A light canvas band or rods with rubber ends or head clamp.
Question—Does the Bucky diaphragm require more time?
Answer—The flat type Bucky may require a very little more time or an increased voltage. The curved types require a little more time.
Question—What is the maximum tube distance to be used with the Bucky diaphragm?
Answer—With the flat type good results are obtained with as much as 60 inches and even more tube distance. If the grid is curved to the arc of a circle—50 inches in diameter, the tube distance will be the radius or 25 inches. For instance, the complete circle of the arc has a diameter of 60 inches, then the tube distance will be half the diameter, the radius or 30 inches.

Question—Can stereoscopic procedure be carried out with a Bucky diaphragm?

Answer—Yes, always, when the tube is shifted horizontally, and up to a certain point vertically. Otherwise Bucky grids would necessitate running the strips in the opposite direction.

Question—Can the tube be tilted towards the center of the Bucky in the tube shift?

Answer—Yes, up to a certain point, then a proportionate change in tube shift and tube distance must be made.

Question—Is it advisable to use intensifying screens with the Bucky?

Answer—Yes.

Question—Why?

Answer—Because the required exposure time without screens would be greater. All factors being equal the time of exposure of screens with Bucky is reduced as much as one-fifth. This in turn not only aids in eliminating motion but adds to the safety of the patient.

Question—What tube should be used with the Bucky?

Answer—In radiographic work as fine a focus tube as possible.

Question—Does the grid have to be released manually?

Answer—No, an automatic release can be installed in the machine. This means that you cock the grid or draw it back in position for operation and then by pressing the bucky release button on the machine (which all up-to-date equipment has), the high tension current goes on and at the proper time the grid is automatically released by a magnetic release.

Question—How long should grid travel before and after exposure?

Answer—Approximately two seconds.

Question—Should the Bucky always operate either vertically or horizontally?

Answer—No.

Question—Why?

Answer—With patient in upright position, the Bucky should be angled to correspond to the general angle of the region exposed with the tube nearly always on the same parallel plane with Bucky. With the patient in the supine position, the Bucky is always horizontally level.

Question—Should there be any graduation on the face of the Bucky?

Answer—Yes. There should be two plane lines, at right angles to the center of the Bucky. When using the Bucky in a position for upright work it is advisable to mark off the size of the film, particularly in 8x10 work. If the bakelite face is used such grooves may be filled with white paint which does not have a great deal of white lead. This has an advantage in centering the patient in front of the film.

QUESTIONS AND ANSWERS PERTAINING TO CALIBRATION IN TECHNICAL PROCEDURES

Question—What is the principal factor responsible for failure to duplicate results?

Answer—Usually the voltage factor.

Question—Why?
Answer—Because of incorrect measurements of voltage.

Question—How would you calibrate?
Answer—Make a complete chart of the machine technicalities, having used a sphere gap to test the control's action for accuracy.

Question—Will the same pre-reading voltage give the same amount of KVP for all MA?
Answer—No. As the MA is increased or decreased, a respectively higher or lower voltage will be necessary to give the same KVP.

Question—Is it possible to successfully calibrate a self-rectifying unit?
Answer—No.

Question—How long does it take to calibrate the ordinary X-ray unit?
Answer—The average time is from two to three hours.

Question—Is calibration injurious to the machine or tube?
Answer—No, not if properly done.

QUESTIONS AND ANSWERS PERTAINING TO THE SPHERE GAP

Question—What is a sphere gap?
Answer—An instrument for measuring high tension alternating current.

Question—How is it used?
Answer—It is connected with the X-ray unit. It measures the volume across the terminals of the X-ray tube.

Question—Can the results of a given spark gap be duplicated on another machine, all factors being equal?
Answer—Yes.

Question—What term is used to designate measure with a sphere gap?
Answer—Kilo-volt-peak.

Question—Of what material are sphere gaps made?
Answer—Brass and copper.

Question—What are the important parts of the sphere gap?
Answer—Spheres of proper size, properly spaced with proper insulation; correct scale; and a lever or cord which enables one to gradually and steadily draw one sphere towards the other.

Question—To what circuit should the sphere gap be connected?
Answer—The tube circuit and as near to the tube as possible.

Question—Will an electric fan affect the sphere gap?
Answer—Yes.

Question—In making the sphere gap test, is it necessary to make more than one reading?
Answer—Yes, make three and divide the total by three. This is the average. A slight variation in voltage, or failing to stop the spheres at the exact point of break-over, may cause slight differences in reading.

Question—Should each and every machine for radiographic purposes be tested for sphere gap?
Answer—Yes, to make correct calibration. On shockproof equipment of modern manufacture this is done at the factory.

QUESTIONS AND ANSWERS PERTAINING TO THE STEREOSCOPE

Question—What is a Stereoscope as applied to radiographic work?
Answer—An instrument constructed to give the interpreter a depth perspective of the region under observation.

Question—What is its purpose?
Answer—To give the third dimension.

Question—For what type of work is it generally used?
Answer—Spine, chest, pelvis, and head.

Question—Of what does the Stereoscope consist?
Answer—A center assembly with rotating mirrors (mirrors will function back and forth and tip laterally), usually two illuminators properly placed on either side of the mirrors (distance between illuminators and mirrors may be increased or decreased by lever action), illuminators may be made to rotate towards the interpreter, one or more electric bulbs in each illuminator, opal blue glass in each illuminator, rheostat for fusing light, some constructed to operate on table or desk, others to hang on the wall, while some are made to operate on a movable stand.

Question—Why change the distance between the illuminators?
Answer—To be able to visualize from a slight angle.

Question—What is the usual position of the illuminators as compared to the mirrors?
Answer—Right angles.

Question—Why tilt the mirrors laterally?
Answer—To horizontally level certain descriptive parts in order to fuse the films.

Question—Why the up and down adjustment of mirrors?
Answer—To make reading more convenient for the interpreter as well as to aid in fusing the films. The vertical center of the mirrors should be in line with the center of the area examined.

Question—What voltage is necessary to illuminate the stereoscope?
Answer—Ordinary house electric circuit. This ranges from approximately 104 to 110 volts.

Question—Why is it necessary that the mirrors move backward and forward?
Answer—To compensate for a slight error in film distance.

Question—How many films are necessary in a stereoscopic set?
Answer—Two.

Question—Why are two films necessary in stereoscopic work?
Answer—Because each film must receive a different focus of direct rays. That is to say, during the exposure of the first film the tube is shifted right of the median line and then shifted the same distance left of the median line when exposing the second film.

Question—What is meant by tube shift?
Answer—One-half of the tube separation. In other words, if the tube separation is 3 inches at 36 inch tube distance, the tube shift is 1½ inches each way of the median line.

Question—What is tube separation?
Answer—The total amount of tube shift.

Question—How is tube separation determined?
Answer—By the approximate distance between the pupils of the normal eye.

Question—What are the various sized stereoscopes?
Answer—8x10, 8x36, 14x17, and 14x36.

Question—Is the rheostat attachment necessary?
Answer—Yes.

Question—Why?
Answer—It fuses the light so that the entire area will assume a more equal density.

Question—Will flat or natural pictures reveal as much information as the stereoscopic views?
Answer—Absolutely no.

Question—Why?
Answer—In flat pictures structures appear as a mass piled in front of one another. Stereoscopic views reveal depth so that objects may be seen far and near from the film. This is third dimension. Further anomalies and malformations in stereoscopic work may be seen from a different angle.

Question—How is the stereoscope operated?
Answer—When visualization is being made, the interpreter should place his eyes as near to the mirrors as possible, certain position of stereoscopic blinds will eliminate unnecessary light and perhaps foreign shadows appearing in the mirrors. Turn on the light. See that illuminator face is at right angles with the base, slide rods, or frame, or center of mirrors. If using the type of stereoscope illustrated in this text, force the assembly away from you within one-half inch of its back bracket. See that the opal glass is free from dust. Properly insert the films. Ordinarily the right film goes in the left box with the marker to you. The left film goes in the right box with the marker away from you.

With PA Vertex stereos the right film goes in the right box with the marker to you and the left film goes in the left box with the marker away from you. The reading is made from the anterior. What is the operator's left is in reality the patient's right side and vice-versa. To read such views from the posterior the right film is placed in the right box with the marker away from you and the left film is placed in the left box with the marker to you. Readings are then made according to the interpreter's right side. That which is the operator's right is actually the patient's right side.

AP Vertex stereos are read the same as AP and Diagonal stereos.

Question—How are they fused?
Answer—Locate some prominent and similar points of structure on both films.

Question—What points are preferable?
Answer—In cervical work, the occipital protuberance, the odontoid of axis, lateral masses, spinous of axis. Of other osseous regions, the spinous processes, pedicles, mammillary processes, or outlines of bodies or extremities are located.

Question—How are they leveled?
Answer—Having located prominent and similar points, rotate the

mirrors until both points are exactly horizontally level. Without changing the lateral tipping of the mirrors carefully rotate them until the two similar points or the images unite fusing as one. Gradually move the entire center assembly forward and then backward until they re-fuse, being very careful not to change the degree of rotation of mirrors or lateral tipping of same. Then manipulate the rheostat until the proper density of light is obtained.

Question—What is the ratio of tube separation to tube distance?
Answer—Approximately one inch separation to one foot of tube distance.

Question—Can the tube be shifted vertically as well as horizontally?
Answer—Yes, when not using Bucky diaphragm unless grids may be had with strips running horizontally for the vertical shift and vertically for the horizontal shift.

Question—What is the vertical shift used for?
Answer—Chest work, generally.

Question—What is the horizontal shift used for?
Answer—Spine, pelvis, head, etc.

QUESTIONS AND ANSWERS PERTAINING TO THE FLUOROSCOPE

Question—What is the fluoroscope?
Answer—A device with which fluoroscopic and visceral examinations are made.

Question—What is its general purpose?
Answer—For the examination of the movable parts of anatomy, to locate foreign bodies, and use in setting fractures.

Question—Of what type are they made?
Answer—Either vertical or horizontal or combination of both. They are called the standard and hand type.

Question—How are they operated?
Answer—The standard is operated in a totally dark room. The hand type may be operated in a light room because it is so made to fit the contour of the front part of the head, excluding all ordinary light between the screen and the eyes of the one making the examinations.

Question—What are the positions ordinarily used in fluoroscopic work?
Answer—Vertical, horizontal, and angular.

Question—What is meant by the angular position?
Answer—When the patient is placed in any position other than the horizontal or vertical position.

Question—What is fluoroscopy?
Answer—It refers to the method in making such X-ray examination with the fluoroscope.

Question—Describe the fluoroscope.
Answer—It consists of a framework supporting an X-ray tube. The tube is enclosed in a lightproof lead glass container. A fluoroscopic screen is mounted in a frame beneath a lead glass plate. (Lead glass should contain the equivalent of 1/16 inch of sheet

lead.) The tube and screen should move up and down synchronously. The framework between the tube and screen consists of special type of perfectly seasoned wood or bakelite—bakelite preferable, and thickness approximately 5/16 of an inch. Between the tube and the partition are two pairs of shutters, directly in front of the tube. They are made to open and close by mechanism on either side of the frame so examiner can conveniently operate during the examination. The shutters increase or decrease the field being visualized. The smaller the field area made by the shutters the sharper the image and the finer the detail. This is done by the closing of the shutters from the top down and the bottom up and from side to side.

Question—Will ordinary plate glass do to cover the screen?
Answer—No.

Question—Why?
Answer—Ordinary plate glass will not offer sufficient resistance to the rays making such a procedure very hazardous to the operator.

Question—Should the hand fluoroscope screen be covered with glass?
Answer—Yes, absolutely.

Question—Why?
Answer—For the same reason as that of the large fluoroscopic screen—to protect the operator.

Question—What other methods are used for protecting the operator in fluoroscopic work?
Answer—Lead rubber apron, lead rubber gauntlets, leaded goggles, and leaded skull cap.

Question—What is meant by a laggy fluoroscopic screen?
Answer—One having a tendency to retain its fluorescent action after the production of X-rays cease.

Question—What effect will a laggy screen have?
Answer—It materially interferes with contrast and detail.

Question—Do fluoroscopic screens deteriorate from ordinary usage?
Answer—Very little, if any.

Question—Will fluoroscopic screens deteriorate with age?
Answer—Yes, but very slowly.

Question—What causes fluoroscopic screen deterioration?
Answer—An inferior binder used in the screen's emulsion for the purpose of suspending the screen's crystals.

Question—Can the fluoroscopic screen be used with any type of unit?
Answer—Yes, so far as transformer and tube are concerned.

Question—Can a grid be used in connection with the fluoroscopic screen?
Answer—Yes, one similar to one used in radiographic work.

Question—What is its purpose?
Answer—To eliminate secondary radiation.

Question—Will grid lines appear when making the examination?
Answer—Yes.

Question—How is the grid used?
Answer—Between the screen and the patient.

Question—What is the better tube to use in fluoroscopic work?
Answer—A medium fine focal line tube.

Question—What is meant by a medium fine focal line tube?
Answer—One having a fine focus rather than a focal point.

Question—What is the width of the medium fine focus line?
Answer—Approximately 5/64 inch.

Question—What capacity tube is generally used?
Answer—5-30.

Question—What is the maximum voltage and milliamperes used within the safety limit?
Answer—88 KVP or a 5 inch spark gap and 3 to 5 milliamperes.

Question—Why is a finer focus tube used?
Answer—To sharpen the fluoroscopic image.

Question—Why is a lesser amount of milliamperes used?
Answer—To lessen the danger to the patient and the tube.

Question—What is the procedure of the operator just before making the examination?
Answer—The operator should remain in the fluoroscopic examination room approximately fifteen minutes before making the examination.

Question—Why?
Answer—As this room is perfectly dark he must remain this period of time so that his eyes will become accustomed to the darkened room.

Question—How should the fluoroscopic exposure be made?
Answer—Intermittently.

Question—Why?
Answer—It aids in prolonging the life of the tube.

Question—Why should the tube be completely covered and insulated?
Answer—To exclude all filament light and protect the operator.

Question—Is there any danger of giving the patient too much fluoroscopic exposure?
Answer—Yes, absolutely.

Question—What is the maximum time of exposure to be used in fluoroscopic examinations?
Answer—Never more than fifteen or twenty minutes at a 15 inch target skin distance using a 1 mm. aluminum filter between the tube and the shutters.

Question—How soon can the examination be repeated?
Answer—Not advisable under thirty days.

Question—What other precautions are used for the safety of the patient?
Answer—Have fluoroscope grounded, unit well insulated and all high tension wires insulated and out of reach.

QUESTIONS AND ANSWERS PERTAINING TO X-RAY TUBES

Question—Who invented the radiator type of tube?
Answer—Dr. W. D. Coolidge of the General Electric Company and it was so named in his honor.

Question—How are they classified?
Answer—Air-cooled deep therapy and water-cooled deep therapy, universal radiator type for general use, portable use, and the right angled dental type.

Question—Name two makes of radiator type tubes.
Answer—Coolidge and Eureka.

Question—How may these be classified?
Answer—Fine focus, medium fine, medium, and so-called broad.,

Question—What sort focal point has the Eureka?
Answer—Fine.

Question—What is the width of this focal line?
Answer—3/64 inch or 3-100, 5/64 inch or 5-100, 9/64 inch or 9-100, and 12/64 inch or 12-100.

Question—Which one is generally used in radiographic work?
Answer—The 5-100 or 9-100 although the 3-100 may be used in extremity work.

Question—When was the Eureka tube placed on the market?
Answer—About the year 1919.

Question—Are there any other types of tubes?
Answer—Yes, the Universal and many others.

Question—What types of Universal tubes are on the market?
Answer—Fine, medium, and broad focus.

Question—When was the Coolidge tube first placed on the market?
Answer—In 1912.

Question—What sort of cathode have these two tubes—Coolidge and Eureka?
Answer—Hot cathode.

Question—Do the Eureka people make another type tube?
Answer—Yes, the oil immersed and the ray proof shield tube, also the right angled dental tube.

Question—What does the hot cathode tube consist of?
Answer—A thin shelled glass bowl with two arms extending in opposite directions. From the center to one end of the tube is the copper anode with its connection to that end of the tube. The other end is known as the cathode with its filament and reflector parts. The anode end is supplied with one wire connection while the cathode end is supplied with two-wire connection.

Question—Which end receives the low voltage?
Answer—The cathode.

Question—What is the usual low voltage?
Answer—6 to 12 volts.

Question—For what is its purpose?
Answer—To heat the filament wire.

Question—Why heat the filament wires?
Answer—To produce electrons.

Question—Why produce electrons?
Answer—To conduct the current from the anode to the cathode.

Question—What happens then at the cathode end?
Answer—The current is whipped back into a stream by the reflector against the anode end.

Question—What is this stream called?
Answer—Cathode stream, or electron stream.

Question—What is the velocity of the cathode stream?
Answer—It depends upon the force of the voltage.

Question—Does the target absorb this stream?
Answer—No.

Question—How are X-rays produced?
Answer—By the bombardment of the cathode stream against the target.

Question—What part of the target receives this bombardment?
Answer—The focal point or line.

Question—What is this point made of?
Answer—Tungsten material.

Question—Why?
Answer—It is sufficiently hard to withstand the impact.

Question—How is it constructed?
Answer—Usually round, the size of an ordinary button and pinned flush into the copper anode.

Question—How is the copper anode or flush cut?
Answer—At approximately an angle of 22 degrees.

Question—How is it finished?
Answer—Ground flush.

Question—How are these ends assembled into the glass bowl?
Answer—Glass bowl is made into two halves, each end completely assembled and then fused together by artificial heat with parts revolving in a certain type lathe.

Question—How are these tubes made of high vacuum?
Answer—By sealing them in an electrical furnace putting through a continual heavy charge of current for a number of hours.

Question—What does this do?
Answer—Heats the anode end or copper to a white heat.

Question—What is the next step?
Answer—Allow the tube to gradually cool.

Question—What effect does this have on the tube?
Answer—Eliminates the gas resulting in a high vacuum instrument.

Question—What is the life of an X-ray tube?
Answer—Indefinite.

Question—Are they guaranteed?
Answer—No.

Question—What is the usual cause of the tube becoming gassy?
Answer—Too heavy a charge or too many consecutive exposures.

Question—What is another cause?
Answer—The tube becoming punctured or the copper anode cracking allowing the tungsten button to become loose.

Question—What is the purpose of the radiator?
Answer—To dispense the heat.

Question—What is another name for a hot cathode tube?
Answer—Self-rectifying tube.

Question—How does this tube rectify its current?
Answer—By keeping its heat below a certain point.

Question—What other means of rectification are there?
Answer—Mechanical rectification, and valve tube rectification.

Question—How is this made?
Answer—By revolving the mechanical rectifier, and by use of valve tubes.

Question—How many types of mechanical rectifiers are there?
Answer—Two, the disc and metal cross-arm.

Question—What is another name for a self-rectifying unit?
Answer—Motorless type.

Question—What is the usual capacity or amperage?
Answer—Ordinarily, 30-60 although a slight increase in milliamperes may be had by decreasing the voltage or KVP.

Question—Why is the focal point line narrow?
Answer—Because it makes sharper outlines adding detail to the pictures.

Question—What type of tube is ordinarily used with the non-shock-proof equipment?
Answer—Ordinarily radiator type in radiographic work.

Question—What is meant by shock-proof tube?
Answer—Tube usually immersed in oil with its wire end absolutely insulated.

Question—Why are hot cathode tubes popular?
Answer—The electronic emission and the high potential may be easily and quite accurately determined.

Question—How?
Answer—By regulating the cathode filament.

Question—What is another name for the anode end of the tube?
Answer—Positive or plus.

Question—What is another name for the cathode end of the tube?
Answer—Negative or minus.

Question—How does gas appear in the tube?
Answer—It is often visible as a hue of greenish fluoroscence, and also noted as a variance in the milliamperes.

Question—Can a small amount of gas in the tube be eliminated in your laboratory?
Answer—Sometimes putting through a charge intermittently will eliminate the gas, otherwise the tube must be returned to the factory for repairs.

Question—What does the discoloration of the tube signify?
Answer—A chemical change within the tube during the production of X-rays or a deposit of tungsten on the inner wall of the tube.

Question—How is this caused?
Answer—By a too high potential or use of the tube beyond its rate of capacity.

Question—Will such a discoloration interfere with the quality of work?
Answer—Not materially, but rather shorten the life of the tube.

Question—How are tubes shipped from the manufacturers?
Answer—In crates with tube suspended by springs and canvas strips.

Question—What is another name for a cold cathode tube?
Answer—A gas tube.

Question—Which is the better for radiographic work?
Answer—The hot cathode.

Question—Is the quality of work produced the same by using either hot or cold cothodes?
Answer—Yes, approximately. Operating the hot cathode work may be speeded up.
Question—What is meant by direct radiation from the tube?
Answer—The radiation emanates from the focal spot or line.
Question—What is secondary radiation?
Answer—That radiation produced when X-rays meet with resistance and are not absorbed.
Question—What type of metal is better used for absorbing secondary radiation?
Answer—Lead.
Question—Of what thickness must the lead be to absorb the ordinary amount of secondary radiation ?
Answer—It should be equivalent to 1/16 inch of virgin sheet lead.
Question—What is meant by virgin sheet lead?
Answer—Chemically pure lead.
Question—What is meant by stray radiation?
Answer—That radiation which is directed from parts of the tube other than the focal spot or line.
Question—What is meant by soft rays?
Answer—X-rays having little penetrative value.
Question—What are hard rays?
Answer—Hard rays are those of short wave length, the result of high potential.
Question—Are X-rays the same as ordinary light rays?
Answer—No, light rays are much longer than X-rays, therefore weaker.
Question—How is the heat from a hot universal anode dissipated?
Answer—Through the wall of the glass tube itself.
Question—Why is copper used in making the anode end?
Answer—Because copper permits rapid removal of heat from the anode.
Question—How is the focal width determined?
Answer—First drill approximately a 3/64 inch hole through a piece of sheet lead. Place the lead sheet halfway between the focal line of the tube and the X-ray film. Make ordinary exposure and the width of the black line on the film will be equivalent to that line or spot in the tube target.
Question—Does pitting the target of this tube enlarge the focal spot?
Answer—No.
Question—Can a storage battery be used to light the filament?
Answer—Yes, but not advisable.
Question—How are the milliamperes registered?
Answer—By an ammeter.
Question—How is the voltage registered?
Answer—Through the tube by a volt meter.

QUESTIONS AND ANSWERS ON ROTATING ANODE TUBE

Question—What is the most recent achievement in present day tube manufacture?

Answer—The perfection of the rotating anode tube.

Question—What principle is employed in its manufacture?

Answer—The principle of placing a tungsten disc on a rotor.

Question—What is the purpose of the rotor?

Answer—To revolve the tungsten disc.

Question—What advantages are obtained by using a rotating anode?

Answer—Greater tube capacities and a smaller effective focal spot.

Question—How many revolutions per minute does the anode usually revolve?

Answer—Usually from 3000 to 3600 revolutions per minute.

Question—Does the rotating anode tube have more than one focal spot?

Answer—Yes.

Question—What are the sizes usually?

Answer—The small focal spot is usually .5 to 1 mm., while the large focal spot is usually 2 mm.

Question—Is there any particular angle of bevel of the focal spot area?

Answer—Yes, usually 15 to 18 degrees.

Question—How are these tubes cooled?

Answer—By air and oil.

QUESTIONS AND ANSWERS PERTAINING TO THE OPERATION OF THE MACHINE

Question—What are the principal factors in technique?

Answer—Distance, exposure, milliamperes, and penetration.

DISTANCE

Question—What does distance refer to?

Answer—In radiographic work, it refers to the distance from the tube target or focal point to the film. This is known as tube distance. Though skin distance does not refer to radiographic work, it means the distance from the tube target or focal point to the skin of the individual. This is used in X-ray therapy.

Question—How is distance measured?

Answer—Usually in inches.

Question—What is another name for tube distance in radiographic work?

Answer—Focal film distance.

Question—What is the standard tube distance?

Answer—That varies with areas or regions to be exposed and by the procedure of certain X-ray technicians. However, distances range from approximately 18 to 72 inches. Dental work usually averages 18 to 20 inches, extremity work 25 to 36 inches, spine work 30 to 60 inches, and chest work 72 inches.

Question—Will the various machines have anything to do with tube distance?
Answer—Greater distance may be used with machines having a greater capacity.

Question—What is the minimum skin distance?
Answer—15 inches. To increase this to 18 inches increases the safety measure and eliminates the danger to the patient. To decrease the tube distance adds danger to the exposure. Altering the tube distance plays a very important part with the patient.

Question—Will the tube play an important part in the distance factor?
Answer—Yes. Larger focal point tubes can be used for greater distances. Smaller focal point for shorter distances. The larger the focal point, the less the detail. The finer the focal point the sharper the detail.

Question—What effect does tube distance have on the film?
Answer—Increased tube distance to a certain point should produce less distortion and detail should be quite satisfactory.

Question—Will changing the tube distance affect radiographic density, all other factors remaining the same?
Answer—Yes. The radiographic density will vary inversely as the square of the distance. Multiplying the distance by two gives one-fourth the density. Dividing it by two, results in four times the density.

Question—Is it wise to alter the tube distance?
Answer—No, not when once fixed.

Question—What distance should be used with the Bucky diaphragm?
Answer—That depends on the ratio of the grid. In other words, how many lead strips to wood strips per inch. This information should come from the manufacturer of the Bucky diaphragm. Perhaps the best results are obtained at 36 inches with the Bucky diaphragm.

Question—What is the objection to using a greater tube distance with the Bucky diaphragm?
Answer—It would mean an increase in penetration or time or perhaps both. This not only adds to the strain of the equipment including the tube but also promotes motion on the film.

Question—Should the tube distance be a constant or variable?
Answer—Constant.

EXPOSURE TIME

Question—What does time refer to?
Answer—It means the actual seconds of exposure, often referred to as milliampere seconds (MAS).

Question—How are milliampere seconds determined?
Answer—By multiplying the number of milliamperes used by the actual amount of time in seconds. For example: If 20 milliamperes were used and 10 seconds of time, for any one exposure, the number of milliampere seconds would be 200. If 100 milliamperes were used for 1/10 of a second, the total number of milliampere seconds would be 10.

Question—Why are milliampere seconds determined in X-ray work?
Answer—Because the safety limit in any one exposure is based on

a certain figure—1200 for all parts of the body except the head and 900 for the head area.

Question—On what distance is the milliampere second limit based?

Answer—Skin distance. Some authorities claim 15 inches while others claim 18 inches.

Question—What effect will milliampere seconds have on the film as to detail?

Answer—With everything else being equal, a lesser amount enables one to do the work instantaneously. This tends to eliminate motion on the film.

Question—Is the automatic hand timer advisable?

Answer—Yes, for exposures under a second and a half or when doing comparative work.

Question—What effect will the various machines have on the time factor?

Answer—The greater the capacity of the X-ray machine, the less amount of time in seconds may be satisfactorily used.

Question—Will alternating the time factor affect radiographic density?

Answer—With all other factors being equal, the radiographic density varies in direct proportion with the exposure time. Doubling the time doubles the density. Cutting the time in two, halves the radiographic density.

Question—Does the time factor have an effect on distortion?

Answer—No. Time (MAS) should be a constant.

MILLIAMPERES

Question—What are milliamperes?

Answer—Refers to the number of milliamperes used through the tube during the exposure.

Question—How are they measured?

Answer—By a milliammeter.

Question—What is the number of milliamperes used in radiographic work?

Answer—Ordinarily varies from 10 to 100.

Question—Is there a standard number of milliamperes to be used for various exposures?

Answer—No. Some technicians prefer to use a certain number while others may use either a greater or lesser amount.

Question—When is a greater amount ordinarily used?

Answer—In chest work, gall bladder work, in that of children, and in conditions of muscular incoordination.

Question—Will the machine have any effect on the milliamperage?

Answer—Only in so far as the capacity is concerned.

Question—Will the tube have any effect on the milliamperage?

Answer—Only in so far as the capacity of the tube is concerned.

Question—Will the milliamperage have any effect om the distortion?

Answer—No.

Question—What effect will the milliamperes have on density?

Answer—Radiographic density varies in direct proportion to the amount of milliamperes used.

Question—Will milliamperes affect contrast?

Answer—Yes.

Question—How does a greater amount of milliamperes affect the film?

Answer—Other factors remaining equal, the density is decreased or a lesser exposure is needed and vice versa with a lesser amount of milliamperage. Milliamperage is a constant.

PENETRATION (Voltage or Kilo-Volt-Peak)

Question—What is meant by penetration?

Answer—Refers to the voltage supplied by the tube.

Question—What is a kilo-volt?

Answer—1000 volts.

Question—What is a kilo-volt-peak?

Answer—Refers to the highest point or peak of the voltage wave employed.

Question—What does gap or spark gap refer to?

Answer—Another term used in place of voltage.

Question—How is spark gap measured?

Answer—By inches.

Question—Does the voltage factor have any effect on detail?

Answer—No, not materially. It only makes it more or less visible.

Question—How is the voltage to the tube measured?

Answer—By calibration or sphere gap.

Question—What is the usual kilo-volt-peak used in radiographic work?

Answer—Usually ranges from 45 to 100.

Question—Can kilo-volt-peak be fixed to use as a standard?

Answer—No.

Question—When is a lower amount of penetration used in radiographic work?

Answer—For extremities and when an extension of exposure time is used.

Question—Does the voltage have anything to do with distortion?

Answer—No.

Question—When is a greater amount of penetration used in radiographic work?

Answer—When heavy individuals are X-rayed or when instantaneous work is necessary.

Question—Does voltage have any effect on milliamperage?

Answer—No, not particularly.

Voltage, kilo-volt-peak, penetration, or spark gap are variables.

QUESTIONS AND ANSWERS PERTAINING TO FILM QUALITY

Question—What makes film quality, technically speaking?

Answer—Detail, contrast, density, and a minimum of distortion.

Question—What causes distortion?

Answer—The poor alignment of film, tube and patient, the distance of the object from the film, and the tube distance.

Question—What types of distortion are there?

Answer—Two.

Question—What are they?
Answer—Magnification, meaning an increased size of the object on the film, and elongation or an irregular or twisted form of the object, not anatomically true.

Question—Are both types detrimental in film analysis?
Answer—Elongation or the twisted type is detrimental. Magnification may not be.

Question—What is called true distortion?
Answer—Incorrect alignment of tube, object and film.

Question—Can this be eliminated?
Answer—Yes, with proper alignment, except for the extremities on the film, especially the 14x17 and larger films.

Question—What is meant by radiographic detail?
Answer—When outlines are clear, clean-cut, and distinct.

Question—What is the primary factor of good detail?
Answer—Part to be X-rayed should be in close proximity to the film.

Question—What is another factor for good detail?
Answer—Fine focal tube.

Question—Will intensifying screens have any effect upon detail?
Answer—Yes. They tend to lose detail.

Question—What causes the screen to tend to lose detail?
Answer—Its speed and size of the screen's crystals. The coarser the grain the more detail is lost.

Question—What important part does the screen play in radiographic work?
Answer—Cuts exposure time, adds materially in producing more contrast.

Question—What is meant by radiographic density?
Answer—The film tendency towards a lighter or darker product.

Question—What amount of radiographic density is desirable?
Answer—This seems to be a matter of opinion. For chiropractic purposes, the lighter film with white sharp outlines and a gray background is the best. For medical purposes both the light and dark films are desirable.

Question—Does penetration have any effect on density?
Answer—Yes, as it increases so does it increase the density and vice-versa when the voltage decreases.

QUESTIONS AND ANSWERS PERTAINING TO THE PROTECTION OF THE OPERATOR

Question—What are the principal steps in the protection of the operator?
Answer—To know that his equipment is grounded and can be safely operated so far as shock is concerned.

Operate in a lead-lined booth or room.

Protect by use of lead apron, gloves, goggles, etc., in fluoroscopic work.

Ethical procedures.

Question—How does the lead booth protect the operator?
Answer—It absorbs the rays.

Question—What rays?
Answer—Secondary.

Question—Should the lead be of any thickness?
Answer—Yes, at least 1/16 of an inch.

Question—How can the operator observe the patient when operating in a lead-lined booth or room?
Answer—Through leaded glass.

Question—How much lead should be contained in the glass?
Answer—The equivalent of 1/16 inch of virgin sheet lead.

Question—How should a leaded booth be constructed?
Answer—With four sides, top, bottom, one side containing door, a piece of leaded glass sufficiently large to make observation, light (the tubular one is the better to use), and sufficient electrical connections inside the booth to plug in timer or foot switch, Bucky release, and perhaps X-ray switch.

Question—What is the result of too much secondary radiation upon the part of the operator?
Answer—A general run-down condition including dental disturbances, alopecia, etc.

QUESTIONS AND ANSWERS PERTAINING TO THE PATIENT

Question—What is a principal step in protecting the patient?
Answer—Make inquiry to previous X-rays.

Question—What type of ray is harmful to the patient?
Answer—Soft ray.

Question—Why?
Answer—Because they accumulate on the surface of the individual.

Question—How are soft rays produced?
Answer—By using a low gap or penetration and extension of time.

Question—How will too many soft rays injure the patient?
Answer—By accumulating on the surface they will burn and destroy tissue, cause the hair to fall, as well as produce the erythema dose, etc.

Question—For what reason are milliampere seconds determined?
Answer—To know when not to over-expose the patient.

Question—What is the limit?
Answer—1200 milliampere seconds for the body except the head and approximately 900 milliampere seconds for the head area.

Question—How long should the patient wait for other exposures after the limit in milliampere seconds has been given?
Answer—20 to 30 days.

Question—What else adds safety to the patient?
Answer—Using an aluminum filter 1 mm. thick and having all high tension wires insulated or well out of reach.

Question—How does the aluminum filter protect the patient?
Answer—Absorbs most of the soft rays.

Question—How can the high tension wires be insulated?
Answer—By shock proofing the equipment.

Question—What effect will grounding the equipment have on the patient?

Answer—Stops all static electricity.

Question—What is static electricity?

Answer—It is said to be electrical current at rest.

QUESTIONS AND ANSWERS PERTAINING TO LINE DRAWING IN FILM ANALYSIS

Question—How many lines should be drawn on lateral cervical film?

Answer—Only one is necessary.

Question—From what points is the atlas line drawn?

Answer—From the center of the darkened area of the anterior arch posterior through the center of the lamina.

Question—How many lines should be drawn on the AP regular film?

Answer—Four lines are necessary.

Question—What are these lines called?

Answer—Basic, median and wedge lines.

Question—From what points are these lines drawn?

Answer—The basic line is drawn through the orbits level with the skull. The median line is drawn at right angles to basic line down through point of bisection. (The point of bisection is half the distance between the inferior medial points of the condyles.) Top wedge line is drawn from jugular to jugular process. Lower wedge line is drawn from a lateral inferior point of one lateral mass to the same point of the opposite lateral mass.

Question—How many lines should be drawn on the base posterior film?

Answer—Actually three lines.

Question—From what points are these lines drawn?

Answer—The lower line (horizontal) is drawn through the center of each transversarium foramen.

The perpendicular line is drawn from the superior point of the nasal spine down through the lower center of the basilar process. The curve line is scribed on the left side (BP view) at or usually near the center of the left transversarium foramen. It represents distance on the left equal to the distance from the center of the base of the odontoid to the center of the right transversarium foramen.

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